JOURNAL

OF THE

SOCIETY OF ARTS.

VOLUME XLIII.

FROM NOVEMBER 16, 1894, TO NOVEMBER 15, 1895.

LONDON:
PUBLISHED FOR THE SOCIETY BY GEORGE BELL AND SONS,
4, 5, & 6, YORK STREET, COVENT GARDEN.

1895.

JOURNAL OF THE SOCIETY OF ARTS.

No. 2192.] *FRIDAY, NOVEMBER 23, 1894.* *[Vol. XLIII.*

ONE-HUNDRED-AND-FORTY-FIRST SESSION, 1894-95.

SESSIONAL ARRANGEMENTS.

The First Meeting of the One Hundred and Forty-First Session of the Society was held on Wednesday, the 21st November, when the Opening Address was delivered by Major-General Sir John Donnelly, K.C.B., Chairman of the Council. The following arrangements have been made for the four meetings before Christmas :—

Wednesday Evenings, at Eight o'clock :—

November 28.—Hiram Maxim, "Experiments in Aeronautics." Sir Richard Webster, G.C.M.G., Q.C., M.P., will preside.

December 5.—E. Hermite, "The Electrical Treatment of Sewage." Sir Douglas Galton, K.C.B., F.R.S., will preside.

" 12.—Thomas Ward, "Manufacture of Salt."

" 19.—Lieut.-General J. Michael, C.S.I., "Forestry."

Papers for Meetings after Christmas :—

Professor William Chandler Roberts-Austen, C.B., F.R.S., "The Separation of Aluminium by the Vautin Process."

A. G. Charleton, A.R.S.M., "The Dressing and Metallurgical Treatment of Nickel Ores."

R. E. CROMPTON, M.I.E.E., "The Use of Electricity for Cooking and Heating."
A. G. STANTON, "Tea."
J. HARRISON CARTER, "Improvements in Milling Machinery."
MAJOR-GENERAL CHARLES E. WEBBER, C.B., "Electric Lighting of Ecclesiastical Buildings."
DR. A. MARKOFF, "Russian Armenia."
CAPTAIN S. PASFIELD OLIVER, "Madagascar."
PROFESSOR WILLIAM LAYTON, "Commercial Education Abroad."
CAPTAIN JOHN SHAKESPEAR, "The Lushais, and the Land they Live in."
C. KRISHNA MENON, "Village Communities in Southern India."
J. W. PARRY, A.M.Inst.C.E., "The Projected Railways of India, and their Prospects."
GLEESON WHITE, "Drawing for Process Reproduction."
ALEXANDER MILLAR, "Technical Carpet Designing."
W. GOWLAND, "The Art of Casting Bronze and Copper in Japan."
C. W. RADCLIFFE COOKE, M.P., "Cider."
W. M. ACWORTH, "Light Railways."
E. MONTAGUE NELSON, "Our Food Supply from Australia."

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Eight o'clock:—

DECEMBER 6, AT 4.30 P.M.—HON. W. LEE-WARNER, C.S.I., "Roman and British Indian Systems of Government."

[This and two of the subsequent meetings will be held at the Imperial Institute.]

January 17, February 14, March 7, 28, April 25, May 16.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four or Eight o'clock:—

January 22, February 19, March 5, April 2, 30, May 21.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

February 5, 26, March 19, April, 23, May 7, 28.

CANTOR LECTURES.

These lectures will be delivered on the following Monday Evenings, at Eight o'clock:—

PROFESSOR VIVIAN B. LEWES, "Modern Developments in Explosives." Four Lectures.

LECTURE I.—NOVEMBER 26.—*Explosives and Explosions.*—Gunpowder—History—Methods rendered necessary by the growth and changes in the character of the guns employed—Modern powders and the methods by which the desired results are obtained.

LECTURE II.—DECEMBER 3.—*Guncotton.*—The improvements which have taken place in its manufacture since its discovery by Schönbein—English service guncotton, and its manufacture—Nitro-glycerine—Dynamite.

LECTURE III.—DECEMBER 10.—*Smokeless Powders.*—The early attempts to utilise guncotton, and the causes of their failure—The smokeless powders of to-day.

LECTURE IV.—DECEMBER 17.—*Blasting Explosives.*—Requirements—Fiery mines—A good safety explosive as great a safeguard as the safety-lamp—Explosives employed—The safety explosives now in use—Roburite, &c.

PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S., "The Arc Light." Three Lectures.
January 14, 21, 28.

ALAN S. COLE, "Means for verifying Ancient Embroideries and Laces." Three Lectures.
February 11, 18, 25.

DR. D. MORRIS, C.M.G., "Commercial Fibres." Three Lectures.
March 18, 25, April 1.

JAMES DOUGLAS, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures.

April 22, 29, May 6, 13.

ERNEST HART, D.C.L., "Japanese Art Industries." Two Lectures.

May 20, 27.

JUVENILE LECTURES.

Two lectures, by PROFESSOR C. VERNON BOYS, F.R.S., on "Waves and Ripples," on Wednesday evenings, January 2 and 9, 1895, at 7 p.m.

PROCEEDINGS OF THE SOCIETY.

CHAPTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session, papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session, three of which during the Session 1894-5 will be at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886, for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of two or more Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

JUVENILE LECTURES.—A Short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures Special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members' who are also entitled to borrow books.

CONVERSAZIONI are held, to which Members are invited, each Member receiving a card for himself and a lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled:—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admission to all Exhibitions held by the Society at its house in the Adelphi.

To be present at all the Society's *Conversazioni*.

To receive a copy of the Weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

All subscriptions should be paid to the Secretary, Sir Henry Trueman Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

HENRY TRUEMAN WOOD, *Secretary*.

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1894-95. It is issued subject to any necessary alterations:—

NOVEMBER, 1894.

1	Th	
2	F	
3	S	
4	**S**	
5	M	
6	Tu	
7	W	
8	Th	
9	F	
10	S	
11	**S**	
12	M	
13	Tu	
14	W	
15	Th	
16	F	
17	S	
18	**S**	
19	M	
20	Tu	
21	W	Ordinary Meeting
22	Th	(Opening Meeting
23	F	of the Session)
24	S	
25	**S**	
26	M	Cantor Lecture I. 1
27	Tu	
28	W	Ordinary Meeting
29	Th	
30	F	

DECEMBER, 1894.

1	S	
2	**S**	
3	M	Cantor Lecture I. 2
4	Tu	
5	W	Ordinary Meeting
6	Th	
7	F	
8	S	
9	**S**	
10	M	Cantor Lecture I. 3
11	Tu	
12	W	Ordinary Meeting
13	Th	
14	F	
15	S	
16	**S**	
17	M	Cantor Lecture I. 4
18	Tu	
19	W	Ordinary Meeting
20	Th	
21	F	
22	S	
23	**S**	
24	M	
25	Tu	Christmas Day
26	W	*Bank Holiday*
27	Th	
28	F	
29	S	
30	**S**	
31	M	

JANUARY, 1895.

1	Tu	
2	W	Juvenile Lecture I.
3	Th	
4	F	
5	S	
6	**S**	
7	M	
8	Tu	
9	W	Juvenile Lecture II.
10	Th	
11	F	
12	S	
13	**S**	
14	M	Cantor Lecture II. 1
15	Tu	
16	W	Ordinary Meeting
17	Th	Indian Section
18	F	
19	S	
20	**S**	
21	M	Cantor Lecture II. 2
22	Tu	For. & Col. Section
23	W	Ordinary Meeting
24	Th	
25	F	
26	S	
27	**S**	
28	M	Cantor Lecture II. 3
29	Tu	
30	W	Ordinary Meeting
31	Th	

FEBRUARY, 1895.

1	F	
2	S	
3	**S**	
4	M	
5	Tu	Applied Art Section
6	W	Ordinary Meeting
7	Th	
8	F	
9	S	
10	**S**	
11	M	Cantor Lecture III. 1
12	Tu	
13	W	Ordinary Meeting
14	Th	Indian Section
15	F	
16	S	
17	**S**	
18	M	Cantor Lecture III. 2
19	Tu	For. & Col. Section
20	W	Ordinary Meeting
21	Th	
22	F	
23	S	
24	**S**	
25	M	Cantor Lecture III. 3
26	Tu	Applied Art Section
27	W	Ordinary Meeting
28	Th	

MARCH, 1895.

1	F	
2	S	
3	**S**	
4	M	
5	Tu	For. & Col. Section
6	W	Ordinary Meeting
7	Th	Indian Section
8	F	
9	S	
10	**S**	
11	M	
12	Tu	
13	W	Ordinary Meeting
14	Th	
15	F	
16	S	
17	**S**	
18	M	Cantor Lecture IV. 1
19	Tu	Applied Art Section
20	W	Ordinary Meeting
21	Th	
22	F	
23	S	
24	**S**	
25	M	Cantor Lecture IV. 2
26	Tu	
27	W	Ordinary Meeting
28	Th	Indian Section
29	F	
30	S	
31	**S**	

APRIL, 1895.

1	M	Cantor Lecture IV. 3
2	Tu	For. & Col. Section
3	W	Ordinary Meeting
4	Th	
5	F	
6	S	
7	**S**	
8	M	
9	Tu	
10	W	
11	Th	
12	F	Good Friday
13	S	
14	**S**	Easter Sunday
15	M	*Bank Holiday*
16	Tu	
17	W	
18	Th	
19	F	
20	S	
21	**S**	
22	M	Cantor Lecture V. 1
23	Tu	Applied Art Section
24	W	Ordinary Meeting,
25	Th	Indian Section
26	F	
27	S	
28	**S**	
29	M	Cantor Lecture V. 2
30	Tu	For. & Col. Section

MAY, 1895.

1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	**S**	
6	M	Cantor Lecture V. 3
7	Tu	Applied Art Section
8	W	Ordinary Meeting
9	Th	
10	F	
11	S	
12	**S**	
13	M	Cantor Lecture V. 4
14	Tu	
15	W	Ordinary Meeting
16	Th	Indian Section
17	F	
18	S	
19	**S**	
20	M	Cantor Lecture VI. 1
21	Tu	For. & Col. Section
22	W	Ordinary Meeting
23	Th	
24	F	
25	S	
26	**S**	
27	M	Cantor Lecture VI. 2
28	Tu	Applied Art Section
29	W	Ordinary Meeting
30	Th	
31	F	

JUNE, 1895.

1	S	
2	**S**	Whit Sunday
3	M	*Bank Holiday*
4	Tu	
5	W	
6	Th	
7	F	
8	S	
9	**S**	
10	M	
11	Tu	
12	W	
13	Th	
14	F	
15	S	
16	**S**	
17	M	
18	Tu	
19	W	Conversazione
20	Th	
21	F	
22	S	
23	**S**	
24	M	
25	Tu	
26	W	Annual General
27	Th	Meeting
28	F	
29	S	
30	**S**	

The chair will be taken at Eight o'clock at each of the Ordinary Meetings, the Cantor Lectures, and the Meetings of the Applied Art Section.

The Meetings of the Indian Section and of the Foreign and Colonial Section will commence at either Half-past Four or Eight o'clock, as may be announced from time to time.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Seven o'clock.

Notices.

EXAMINATION PRIZES.

The Council have received, towards the Prize Fund in connection with the Society's examinations, donations from the following City companies :—

Clothworkers' Company	£30	0	0
Goldsmiths' Company	25	0	0
Merchant Taylor's Company ..	10	10	0
Skinners' Company	5	5	0

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday, November 21, 1894; Major-Gen. Sir JOHN DONNELLY, K.C.B., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society :—

Agabeg, Frank J., Sitarampore, Bengal, India.
Arthur, Matthew, Fullarton, Troon, Ayrshire.
Barnes, Charles Barritt, Florencedale, Selhurst-road, South Norwood, S.E.
Batalha-Reis, J., Portuguese Consulate, Newcastle-upon-Tyne.
Berkley, James Eustace, H.H. the Nizam's Guaranteed State Railways, Secunderabad, India.
Blenheim, William, Egham, Surrey.
Bourne, Charles William, M.A., King's College School, Strand, W.C.
Brett, Captain Walter Percival, R.E., Royal Military Academy, Woolwich, Kent.
Brousson, R. P., Geraldton, Sidcup, Kent.
Bynoe, Frederick Oatley, Gwendoline-house, Saltram-crescent, W., and 68, Cornhill, E.C.
Channon, Harry C., Cotswoldbury, Glengall-road, Woodford-green, Essex.
Christian, William, 21, Queen's-gardens, Hyde-park, W.
Cooze, A. W., Elvaston, Friern-park, North Finchley, N.
Craddock, Albert, 51, Weymouth-street, W.
Crawford, Archibald A., 1, Esplanade-road, Bombay, India.
Crewdson, Miss Gwendolen, The Barons, Reigate, Surrey.
Daw, Zacharias Williams, 11, Queen Victoria-street, E.C.
Denny, Thomas James, 95, Finsbury-pavement, E.C.
Desai, J. V., B.A., 19, Montem-road, Forest-hill, S.E.
Edwards, John, 4, Great Western-terrace, Glasgow.
Fearon, Henry Charles Digby, Stanhope-lodge, Herne-hill, S.E.
Ferguson, Alastair Mackenzie, Nanuoya, 14, Ellerdale-road, Hampstead, N.W.
Field, Frederick Arthur, Upper Marsh, Lambeth, S.E.
Fox, Charles, 104, Ritherdon-road, Upper Tooting, S.W., and Junior Constitutional Club, Piccadilly, W.
Fox, Charles Allen, M.R.C.S., Martock, Somersetshire.
Francomb, Richard Walker, Alderman, J.P., Wilderspool, Warrington.
Garland, James Allen, Lisburne Mines, Ystrad Meurig, R.S.O., Aberystwyth.
German, Major James, J.P., Belmont, Sevenoaks, Kent.
Green, W., 473, Oxford-street, W., and Pinner-wood-house, Pinner, Middlesex.
Greensill, Frank, 4, Windsor-terrace, Douglas, Isle of Man.
Hawkes, W. Clifford, 22, Old Steyne, Brighton.
Hepworth, Norris Rhodes, Torridon, Headingley-hill, Leeds.
Hiller, H. Croft, The Whins, Withington, Manchester.
Hindley, Charles Albert, 70, Welbeck-street, W.
Huard, Thomas, R.N., 125, Ilderton-road, Camberwell, S.E.
Inglis, Hon. James, Sydney, New South Wales.
Ironside, William Allan, 1, Gresham-buildings, E.C.
Kelly, William John, 43, King's-road, Camden-town, N.W.
Kilgallin, Charles J., 55, Marylebone-road, N.W.
Latham, Stanley A., 4, Essex-court, Temple, E.C.
Leaf, Arthur H., 9, St. Paul's-churchyard, E.C.
Lewis, Henry Ryan, 7, Drapers'-gardens, E.C.
Lowdon, David, 23, Kingsland-crescent, Barry Docks, Barry, Glamorganshire.
Malvern, Thomas, 2, Rothsay-villas, Leighton-road, Cheltenham.
Müller, Henry Adolphus, 3, North-road, Entally, Calcutta, India.
Oke, Francis Robert, 5, Coppenhall-terrace, Crewe, Cheshire.
O'Shaughnessy, R., Bangalore, India.
Pace, Thomas Richard, 14, The Chase, Clapham-common, S.W.
Pain, James Charles, jun., Manhattan, Streatham, S.W.
Parry, Joseph W., Northolt, Blythe-road, Bromley, Kent.
Porter, Edmund Vernon, 44, Manor-road, Beckenham, Kent.
Rawes, Lieut.-Colonel William Woodward, R.A., Junior United Service Club, S.W.
Restler, James William, Southwark and Vauxhall Water Company, Southwark-bridge-road, S.E.
Robinson, William Leckie, The Elms, Coventry.
Roget, John Lewis, M.A., 5, Randolph-crescent, Maida-hill, W.
Simmelkjœr, Sophus, 8, Pemberton-gardens, Upper Holloway, N.
Spriggs, Joseph, Foxton, near Market Harborough.
Squirrell, Henry Thomas, 5, Station-road, Bexhill-on-Sea.

Standen, Joseph Henry, Broadlands, Streatham, S.W.
Suys, Jos, D.Sc., Hertford County College, Silesia-house, High Barnet, N.
Swinton, Alan Archibald Campbell, 66, Victoria-street, S.W.
Sykes, Clement Moriscrip, Kutch Mandvi, Kutch, India.
Thomas, John, 18, Wood-street, E.C.
Tottenham, Charles, 1, Grosvenor-place, S.W.
Travers, Major John Amory, Dorney-house, Weybridge, Surrey.
Upton, Lionel, The Stock Exchange, E.C.
Walkley, William Henry, 265, Kentish-town-road, N.W.
Walter, Louis H., 56, Victoria-street, S.W.
Warner, Hon. W. Lee, C.S.I., 4, Wilmington-gardens, Eastbourne.
Whitehead, Percy, Barton Pines, near Paignton, Devonshire.
Wilson, Sidney, King's Land, Sayers-common, Hurstpierpoint, Sussex.

The CHAIRMAN delivered the following

ADDRESS.

Under the Bye-laws it is the duty of the Chairman of your Council to deliver an address at the commencement of the Session. It is not a question of his having anything to say to which even he may consider it is worth your listening; it is simply his duty to frame an address. Your Council having done me the honour of electing me Chairman for the year, I find myself invested with this somewhat onerous perquisite of office, which I would fain hand over to some one more competent for the task, or who at least felt himself imbued with a mission to fulfil. But as this is not provided for by the before-mentioned Bye-laws, which I above all others am bound to respect and enforce for the time being, I have thought that I should best execute my task by calling attention to certain parts of the history of the Society—especially those parts which deal with the promotion of education, a subject in which, as you will understand, I am specially interested—and see what lessons for the future may be drawn therefrom. Though I may not be able to make my narrative very interesting, the experience of the past will, I believe, be found very instructive at the present moment. Before proceeding, however, let me remark, parenthetically, how very useful a complete history of the Society would be, and express a hope that some day, and that before long, it may be taken in hand. In saying this, I trust I may not be thought to undervalue much admirable work that has already been done in the way of collecting materials for such a history in a pamphlet called "The Society of Arts, Past and Present; with Suggestions for the Future," by the late Mr. S. T. Davenport, for long an officer of the Society, and in a History of the Society, published in *Engineering* in 1891. From these I have gathered nearly all the historical materials for my present address, while at the same time I availed myself of the addresses of my predecessors in office, who have, to a greater or less degree, dwelt on historical considerations, which naturally formed the foundation of their lucubrations, as of mine. I say naturally, because this Society is not like such societies as the Royal, or the Geographical, the Astronomical, or the Antiquarian. They have precise aims and limits; their presidents have their several tasks clearly defined for them—the state of knowledge at a certain date; its advance since that date; and the influence of the particular Society on that advance.

The field covered by the operations of the Society of Arts is so large and so slightly-defined, that in anything of the nature of an hour's address, it is necessary, in the first place, to select but a small portion of that field, and, in the second place, generally to show how it comes to pass that we have anything to do with it. That I am not exaggerating the variety of the interests which the Society has been established to promote will be evident when I quote from an address of the Council in 1845. It is there stated—"We feel that, in our position as a Society, in our history, in the patronage we possess, and in the influence we might wield for the accomplishment of any great and good object, some grievous fault must attach to us, either collectively or as individuals, if we be not found coming forward and prominently exerting ourselves as the zealous, practical, and effective promoters of all that is most beautiful in art, most useful in science, or most valuable in the manufactures and commerce of the country." This is a high ideal. It is not for me, or any member of the Society, but for others to say how far we have lived up to it—how far we have accomplished our aims. I have, however, I trust, said enough to justify me in confining my attention this evening to one branch of our operations.

Anyone who studies the history of the Society in times past must be struck, I

think, by the wisdom with which its efforts have, on the whole, been directed. Its energies and somewhat limited means have not been employed in furthering schemes which already promised success—in gathering the ripe fruit—but rather in tilling and preparing the ground. Taking a large and enlightened view of the possibilities of the time, the Society has employed itself in initiating or helping others to initiate any scheme which might further arts, manufactures, and commerce, and in promoting education in its broadest and widest sense. In thus preparing the ground, sowing the seed, and showing how it should be cultivated, its operations have been essentially altruistic. It has been content to sow while others have reaped.

As I have before said, it is to the educational side of the Society's operations that I propose to call your attention this evening, and this not in any way with the object of blowing its trumpet, but by taking stock of the past, to give some guide—the only safe guide, I believe—to the operations in the future, not only of our Society, but of other bodies engaged in forwarding the like object.

To William Shipley, a landscape painter, "who from a well-grounded persuasion of the extensive utility of the art of drawing to this nation, erected the academy in the Strand, opposite Exeter Change," is due the credit of having founded the Society of Arts. His proposals for raising, by subscription, a fund to be distributed in premiums for promoting improvements in the liberal arts and sciences, manufactures, &c., were made in 1753—eight years after the suppression of the Jacobite rising of '45—at a time of great literary activity, but when the agriculture, the arts, the manufactures of the country were at perhaps as low an ebb, compared with the Continent, as they have ever been. The next year, 1754, a meeting was held at Rawthmell's Coffee-house, in Henrietta-street, Covent-Garden, to consider the propriety of establishing a Society for the Encouragement of Arts, Manufactures, and Commerce. The only learned societies existing at that time in the kingdom were the Royal Society, founded in 1660, and the Society of Antiquaries, which was founded in 1701, and incorporated in 1751. In the opinion of those present at Rawthmell's Coffee-house, it was considered that drawing was absolutely necessary in many employments, trades, and manufactures, and that the encouragement thereof may prove of great utility to the public. If any of those gentlemen had managed to live another 140 years, they would have been gratified, no doubt, at finding that drawing was now a compulsory subject of instruction in elementary schools in England and Wales, though still only optional in Scotland, and but sparsely cultivated in Ireland. Farseeing as they were, however, these gentlemen — those names are, I trust, preserved somewhere — had to satisfy themselves with offering prizes, which were duly advertised on the 29th March, 1754, to boys and girls for drawing, besides offering premiums for the discovery of cobalt in England, the growth of madder—the price of which had been raised to an extravagant figure by foreign growers and importers—and the manufacture of buff leather. It is interesting to find that among those boys and girls who received prizes for drawings in 1755—the first year of their award—was Richard Cosway (then under 12 years of age), who became the celebrated miniature painter and Royal Academician. Of his works the Society possesses two examples—the portraits of William Shipley, who founded the Society, and was its first secretary, and of Dr. Templeman, who was secretary from 1760 to 1769. Among others who received the premiums of the Society, and subsequently became distinguished artists, were :—John Bacon, for a figure of Peace; Joseph Nollekens, for a model of a farmer with a kid; William Woollett, the engraver, for a figure drawing. This was in 1759; while, in 1760, there oocur the names of Thomas Banks, John Mortimer, George Romney, and Richard Earlom, the mezzotint engraver. In 1766, John Flaxman, then only eleven years of age, appears in the premium list, and, in 1788, Thomas Bewick writes that "the favourable impression which some of my juvenile performances have met with from the Society of Arts, emboldens me to again submit my labours to their view." In later years, we find the names of Lawrence, Turner, Mulready, Ross, and Landseer; Frith, Millais, and Hook.

The prizes seem to have been restricted to students who were under twenty or twenty-one years of age; and were given principally for drawings made from a collection of sculpture and casts formed for the Duke of Richmond between 1750 and 1756, by John Wilton, which collection his Grace patriotically placed at the disposal of the Society for this purpose; and for drawings made at the academy which had been established by William

Shipley. I may mention in this connection, as showing what the State was doing, and what other opportunities were afforded to students, that the British Museum, in the establishment of which some of the early patrons of the Society of Arts seem to have largely participated, was not opened to the public till 1759. It had its origin in the bequest by Sir Hans Sloane—who died in 1753—of his collection of natural history, his large library, and his curiosities, in the purchase of which he had, it is said, expended £50,000, to the use of the public on condition that Parliament should pay £20,000 to his executors. The money for this, and the purchase of Montague-house and grounds, was raised by a public lottery, with guinea tickets. The National Gallery was not established until some seventy years after the Society of Arts was founded.

The Royal Academy, which was founded in 1768, grew out of the exhibitions of the works of the competitors for the prizes offered by the Society of Arts. Before that took place, however, in 1755, Mr. Henry Cheer, one of the judges in the first Art Competition, proposed to the Society "a plan for an academy of sculpture and painting," accompanied by a draft of a proposed Charter of Incorporation, and it is probable that when William Shipley proposed the establishment of a Society for the Encouragement of Arts, Manufactures, and Commerce, he had in view principally the encouragement of art. However that may be, in 1760 Francis Hayman, chairman of the committee of artists, requested the Society to allow an "Exhibition of Polite Arts," to be held in their great room. This was granted, and the first exhibition of works of native artists was opened on the 21st April, 1760, in the Society's rooms in the Strand, near Beaufort-buildings. The origin of these exhibitions is thus recorded in the first volume of the Transactions of the Society :—"The reputation acquired by candidates in consequence of their performances remaining for some time under the inspection of the Society, before and after adjudication, occasioned the artists in general to apply for an exhibition of their works in the Society's great room, which request was accordingly complied with, and repeated for several years. Hence arose the annual exhibition of the rival artists who formed themselves into separate bodies." According to the writer of the article in *Engineering*, these were called the "Free Society of Artists," and the "Society of Artists of Great Britain," and out of the split grew the Royal Academy, which appears to have been assisted, at the outset, from the funds of the Society of Arts.

"The Society having been thus far, fortunately successful," I am quoting again from the Transactions, "in rearing the infant arts in this kingdom to such maturity as qualified them for Royal favour, next confined the award of their premiums to those who may intend to be professors of the arts, or such young persons of rank and eminence who may probably become hereafter the patrons and patronesses of the fine arts. Encouragement has also been given to those branches of the polite arts, which will more immediately tend to improve the manufacturers and consequently promote the commerce of the country."

This may sound rather tall talk. But it must be remembered that the Society became very rapidly influential. A large number of well known and distinguished men joined it at the outset. The signature book of the Society, which is dated 1754, but continued in use for some time after, shows that among its members were a considerable proportion of the peerage — I may mention the Dukes of Devonshire, Marlborough, Portland, and Queensberry, and apparently nearly all the eminent Commoners of the day, such as Samuel Johnson, Boswell, and Topham Beauclerk; Henry Cavendish, Benjamin Franklin, and William Hunter; Sir W. Chambers, the architect; George Colman, the dramatist; David Garrick and Gibbon, and John Howard, the philanthropist; Hogarth, Allan Ramsay, and Sir Joshua Reynolds; Horace Walpole, and John Wilkes. Goldsmith was not a member, but was an unsuccessful candidate for the secretaryship. The only speech Dr. Johnson is said to have made on his legs was delivered in the meeting-room of the Society of Arts. Before leaving this sample, if I may so say, of the early list of patrons of the Society, I must not omit the name of John Angerstein, whose fine collection of pictures formed the nucleus of the National Gallery. It will thus be seen that in any movement which the Society supported it could throw great weight and influence.

It is amusing to find the Society in those early days trying a kind of graduated income tax in a small way. Thus the contribution of a Nobleman was five guineas, while that of a Commoner was generally only two. Among the few Commoners who gave five guineas were General Robert Clive (afterwards Lord Clive), and William Pitt (afterwards Earl of Chatham).

I have said enough I believe to show to what extent the Society influenced art education in its early days, and must now hurry on to its later work. But before doing so it is as well perhaps to call attention to the fact that the Brothers Adam having, in 1768, commenced their scheme for erecting a handsome set of houses on the piece of land formerly belonging to Durham-house—famous for such distinguished residents as Lady Jane Grey and Sir Walter Raleigh, among others—an arrangement was made with them for the erection of the building which the Society now occupies. The first stone was laid by Lord Romney, then president of the Society, on the 28th March, 1772, and in June, 1774, the Society entered on its new premises. It was thought desirable to take advantage of the opportunity afforded, by the fine meeting room in the new house, to attempt to give a fitting representation on its walls of the powers of the English painters whose works had been first exhibited under the auspices of the Society. A proposal was therefore made to some of them in 1774, through Mr. Valentine Green, the engraver, a member of the Society, who took much interest in its welfare, to paint eight historical and two allegorical pictures. For the former, application was made to Angelica Kaufmann, Sir Joshua Reynolds, Benjamin West, Cipriani, Dance, Mortimer, Barry, and Wright; for the latter, to Romney and Penny. The scheme came to nothing, it is said, mainly owing to the opposition of Reynolds. This may be so; but seeing that the only payment offered to the artists was the profits of an exhibition of their pictures for four months, I think we need scarcely go so far a-field to seek the reason for the "promising" scheme coming to grief. In 1777, however, Barry, who is described as being at that time young and enthusiastic, and having 16s. in his pocket, offered to do the works which now surround your rooms, apparently for nothing more than the cost of the canvas, paint, and frames; these frames he designed as you see them, and for them the Society paid £100 17s. I am glad to say, however, that the young and enthusiastic artist did not remain entirely unremunerated, for the public exhibition of his works, which was held at the expense of the Society, and was visited by some 9,950 persons, produced about £500. The remuneration was not extravagant, and he complained that his works were being neglected, while thousands of pounds were being squandered upon a "jubilee of hackneyed German music; an empty hubbub of hundreds of fiddles and drums, which was dissipated into the air as soon as performed." But still it is something to know that, having worked in faith, with zeal, his faith was not altogether misplaced pecuniarily, and that for a time his works were the talk of the town, as being the first attempt in England to revive the art of covering walls with large decorative pictures.

The history of the Society to the end of the 18th century was one of great brilliancy of achievement, though marked by some vicissitudes; and though I am desirous of directing your attention this evening especially to its broadly educational side, it is only right to remind you that it was making, at the same time, great and successful efforts to advance agriculture and agricultural machinery, to which it devoted much attention, and by its premiums and investigations, led to many most important improvements. Again, it devoted much attention to pastures and root crops, many of the latter, which are now generally cultivated, being at that time either unknown or but seldom employed; to trade and commerce, in which it was instrumental in opening up numerous new fields; to forestry, the offer of premiums inducing many landowners to plant timber; to manufactures and machinery, in which it was instrumental in initiating or forwarding many of the most important improvements which so greatly influenced manufacturing industry at the latter part of the last and the commencement of the present century—and this notwithstanding that it worked till 1842 hampered by a self-denying ordinance which precluded patented inventions from consideration at its meetings; and, lastly, to art processes, such as aquatint, mezzotint, wood engraving, and engraving on steel, as well as to pigments, oils, and varnishes; while the arts of casting and chasing were also encouraged.

From the beginning of this century to about 1844 may be said to have been somewhat a period of decay; and in that year the Society had evidently fallen to a rather low ebb, for Mr. Davenport recounts in his history how, on the first occasion of his being present at a meeting in the November of that year, the only remaining stock in the Society's possession was ordered to be sold out to pay its debts. With its sale the Society of the past may be said to have ceased to exist.

In 1847 the Society was incorporated by Royal Charter, owing largely, I believe, to

the exertions of the late Mr. Thomas Webster, Q.C., the father of our late distinguished Chairman of Council. In the same year the late Sir H. Cole (then Mr. Cole) proposed that the Society should organise an annual exhibition of pictures of one or more of the best artists of our own country, the principal object of this Exhibition being to obtain a fund for the purpose of forming the nucleus of a gallery to "worthily exemplify the state and progress of British art." The artist whose works was exhibited was to be commissioned to paint a picture without dictation as to subject or size, and when painted the picture was to be presented to the National Gallery, with a view to the establishment of a National Gallery of British Art. In 1848 an Exhibition was held of the works of William Mulready, R.A., and in 1849 of those of William Etty, R.A. Both of these Exhibitions failed to realise sufficient money to carry out the object for which they were undertaken. Indeed, the Etty Exhibition, owing to the cost of collecting the works and bringing them to London entailed a considerable loss to the Society. But with the small sum realised by the Mulready Exhibition two examples of his life studies were purchased and presented to the National Gallery. The idea of going on with these Exhibitions in order to found a National Gallery of British Art was therefore abandoned, but two Exhibitions of the same nature were subsequently undertaken, in 1855, of the works of the brothers John and Alfred Edward Chalon, and in 1860 of those of Sir William Ross, R.A.

In 1846, prizes were offered to manufacturers and designers for the production of articles of everyday use, and it may be interesting to mention that in the class for jugs, mugs, and plates, the prize was awarded by the jury, of which Sir W. Ross, R.A., was chairman, to a tea service manufactured by Messrs. Minton, and designed by "Felix Summerly," who turned out to be Mr. Henry Cole. These Exhibitions, gradually enlarged in their scope to include all kinds of British manufactures, were continued in 1847, 1848, and 1849. Special technical exhibitions, such as of lithography and bookbinding, were also held during those years, and in 1852 of photography. By 1849, the Exhibitions of manufactures had become so popular and so large that they had outgrown the resources and available premises of the Society, so that for 1850 an Exhibition of Ancient and Mediæval Art was substituted. This, it was hoped, would be of assistance to artists, manufactures, and workmen as a preparation for the Great International Exhibition of 1851, to which the Exhibition of British Industries had led up. As is well known, that International Exhibition originated with the Society, and its then President, the late Prince Consort. But the first steps having been taken by the Society, it soon became necessary to appeal to the Government for aid and support. A Royal Commission was formed, and took over the further management. That Royal Commission is still in existence, owning considerable property—the proceeds of the Exhibition of 1851, which were invested in the purchase of the Kensington-gore Estate—and it has been, in a very substantial way, the fairy godmother to numerous public institutions, doing, I believe, good public service—though when I call to mind the criticisms I read in the English Press of one of them—the South Kensington Museum—I say so with bated breath.

That Exhibition of 1851 has been the parent of innumerable other International Exhibitions with which this Society has been more or less concerned. With the very last—at Chicago—as you are aware, it was very intimately concerned, your Council having been constituted a Royal Commission to administer the Parliamentary grant of £60,000, to organise the British section. On the subject of these various Exhibitions and the connection of this Society with them, I do not propose, as they have been most fully dealt with from time to time in this room, to trouble you with many comments to night. They have afforded the cynic an endless opportunity for caustic observation. They have not answered to all the high expectations formed of them, or, at all events, expressed about them, by injudicious but enthusiastic advocates. They have failed in many respects. They have not brought peace into the world. I do not know that they have helped the sword, except by exhibiting the most modern improvements for shortening the soldier's and sailor's life. But they have done this. They have given a greater impetus than anything else to science and art and technical education, yes, and to elementary education as well, in this country. If any one thinks I am exaggerating, let him look back at the influence of the 1851 Exhibition in awakening people to our shortcomings in the matter of industrial art; to the effect it had on the country and Parliament in the matter of art instruction. Or again, let

him look back to the Exhibition in Paris in 1867. The conclusions forced on the minds of all intelligent English visitors to that Exhibition, on the subject of scientific technical instruction, were focussed, as it were, by the celebrated letter which Mr., now Lord Playfair, wrote to Lord Taunton, and which Lord Granville sent, with comments of his own, to the *Times*. It was published in that journal on the 29th May, 1867.

The next year, 1868, a Conference on Technical Education was held by the Society in these rooms. It lasted for two days—the 23rd and 24th January—and was very largely and influentially attended, among those taking part in it being Earl Granville, Earl Russell, Mr. Bruce, Mr. Cowper, Mr. Goschen, Mr. Villiers, Mr. George Dixon, Mr. Samuelson, Mr. Stansfeld, Dr. Lyon Playfair, Mr. Cole, and many other men of note. The resolutions of this Conference dealt not only with technical education, but with the necessity, which had been forced prominently into notice, for improved primary education for the working classes generally.

Shortly afterwards—on the 24th March, 1868—on the motion of Mr., now Sir B. Samuelson, Bart., the House of Commons granted a Select Committee, of which he was appointed chairman, "to inquire into the provisions for giving instruction in theoretical and applied science to the industrial classes." The first three of their conclusions were—(1) That, with the view to enable the working classes to benefit by scientific instruction, it is of the utmost importance that efficient elementary instruction should be within the reach of every child; (2) that unless regular attendance of the children for a sufficient period can be obtained, little can be done in the way of their scientific instruction; (3) that elementary instruction in drawing, in physical geography, and in the phenomena of nature should be given in elementary schools. Throughout these discussions the object-lesson afforded by the Paris Exhibition of 1867 was universally acknowledged to be the main feature of the movement.

Then, in February, 1870, the Society held a Conference on National Education, at which Lord Henry Lennox, the Chairman of Council, presided. This, again, was well attended by the leading people interested in education.

It is a matter of common knowledge how great an influence these conferences, with the conclusions and the evidence on which the report of Mr. Samuelson's committee was based, had in forwarding Mr. Forster's Education Bill of 1870.

Before leaving this subject of Exhibitions altogether, I should like to mention a little episode which is amusing and interesting, as showing how nearly the Society turned back after having put its hand to the plough, and how important and far-reaching might have been the results of this tergiversation. In 1845 there were barely 300 members of the Society. The members had increased in 1850—after you will remember its activity in Exhibitions—to over 660. On the 12th March of that year Mr. Cole resigned his membership of Council in consequence of a motion having met with general support in that body, to alter the bye-laws in a manner which would have led to the discontinuance of the annual Exhibitions. On the 3rd April the annual meeting of the Society was held. Between the 12th March and the 3rd April, however, Mr. Cole seems not to have been idle—I do not think he ever was idle; at all events, I can speak for the 25 years that I was pretty intimately associated with him—for at that general meeting the Council was turned out. He was first made deputy-chairman and then chairman, delivering his first address as chairman in January, 1851, by which time there were considerably over 1,000 members. There are now some 3,250.

I must now, however, in tracing the educational efforts of the Society, hark back a little. In 1851, in accordance with a proposal made by Mr. Cole in his address, as chairman, the Society took steps towards the establishment of elementary drawing and modelling schools, chiefly for artisans, not only with a view to the advantages which these useful arts would afford in manufactures, but also "to occupy the young in pursuits tending in every way to their improvement, and to provide them with the most wholesome source of instruction and enjoyment." The Drawing and Modelling Schools for Artisans were to be established by the various localities, and taken under the superintendence of, and assisted by, the Society of Arts under certain conditions. To these I need not refer further, for the schools were originally intended to be supplementary to, and more or less feeder to, the Government Schools of Design, which had been in existence for some years. When the Schools of Design were remodelled, and the Department of Practical Art established in 1852, under the Board of Trade, it became unneccessary for the Society of Arts to proceed further with their project.

Another action of the Society, however, which also arose out of the Exhibition of 1851, has continued with great advantage to the present time. I refer to the Union of Institutions which the late Mr. Harry Chester, then one of the Assistant Secretaries of the Education Department, and a Vice-President of this Society, proposed at the end of 1851. A Conference was held the next year, at which the late Lord Lansdowne, K.G.. presided, followed by a dinner at the 'Freemasons' Tavern, at which Lord Carlisle presided, when the Union of Institutions was formally launched, the object being to aid and develop the work of the various Literary and Scientific Institutions and Mechanics' Institutes of the country. A scheme of examinationin math ematical and experimental observations, mechanical and social sciences, as well as in fine arts, moral and metaphysical science and literature, was published early in 1854, and it was proposed that they should take place in March of the subsequent year. They did not, however, commence till 1856, when 56 candidates were examined at the Society's House. The scheme of examination had been a good deal modified in the interval—the 18 subjects in which examinations were held being book-keeping, arithmetic, algebra, mensuration, geometry, mechanics, chemistry, animal physiology, botany, agriculture, geography, physical geography, English history, English literature, Latin, Roman history, French, and German.

In order to enable candidates in the country to avail themselves of these examinations, the system of holding them through the agency of local committees, to whom the papers were sent from London, was instituted in 1858. A similar plan was soon after adopted for the examinations of the Science and Art Department, and subsequently for the Oxford and Cambridge Local Examinations. The scope of the Society's examinations was gradually enlarged, till the number of subjects in which they were held amounted to 36. In 1869, however, it was decided to omit those subjects in which the Science and Art Department examined and made payments on results. In the programme of 1870, therefore, 17 of the 36 subjects were struck out.

I must not omit to mention in this connection that in 1859 the Society took up the question of musical pitch, and in 1865, at the instigation of Sir Henry Cole, that of musical education. This eventually led to the foundation—I think I may safely say almost entirely by his exertions—of the National Training School for Music at Kensington-gore, on a somewhat novel principle, it being supported not by fees, but by scholarships provided by different localities. The late Sir Charles Freake, Bart., provided the house for the school at his own expense, and the Royal Commission for the Exhibition of 1851 gave the site. The school was enlarged in 1883, and was granted a charter as the Royal College of Music, a new home being provided for it on the Commissioners' land by the munificence of Mr. Samson Fox.

To return to the more immediate operations of the Society. In 1872, I had the honour to bring before it a scheme for examinations in Technology, which were to be supplementary to the examinations of the Science and Art Department. The scheme, after receiving the approval of the Council, was submitted to a Conference in this room, at which His Royal Highness, Prince Arthur, K.G., presided, on the 20th July of that year. The Lord Chancellor, and a number of other gentlemen interested in the matter, attended. Their names are given in the *Journal* of the Society for the 26th July, 1872, which reports the proceedings. The scheme was well received by the Conference, but, I am bound to admit, there was not much enthusiasm. Even in 1872 technical education was not a phrase to conjure with; quite the contrary; for I remember going with General Eardley-Wilmot—at that time Chairman of Council—and some other members of the Council to a town in the north of England, where we exhausted all our eloquence to forward our scheme. But we soon found that a polite reception was all we were to expect. The manufacturers would have none of our Technology. Why should trade secrets be the talk of the class-room? However, schemes of examination in the Technology of various branches of manufacture were prepared by committees, and examinations were held in five subjects in 1873—the manufactures of cotton, silk, paper, and steel, and carriage building. The number of subjects was gradually increased, till, in 1878, there were 15. The number of candidates was small, being 6 the first year, and 36 the second. In 1878, however, payments on results were offered to the teachers of the successful pupils, similar to those made for science subjects by the Science and Art Department; the number of candidates then went up to 184. The funds for these pay-

ments were liberally provided by the Worshipful Company of Clothworkers. In 1879 the City companies, who were in a position to continue these payments on results, which this Society was not, proposed to take over the examinations. This was agreed to, and they have been carried on by the City and Guilds' of London Technical Institute, with some modifications and considerable additions, ever since. While under the Society of Arts, the scheme of the examinations was briefly this:—Three papers, of varying degrees of difficulty, an elementary, an advanced, and an honours paper, were set in the technology of each manufacture, the candidate selecting whichever he felt himself competent to take; but he did not obtain a certificate unless he showed he was conversant with certain branches of science bearing on the technology of the subject, by passing the examinations of the Science and Art Department; and further, that he was practically qualified as a workman, by producing a certificate from his employer as to his rate of wages.

In 1873 when the Examinations in Technology were commenced, it was proposed to discontinue the examinations in all the other subjects; but such strong representations were made by the Institutions in Union against this course that the resolution of the Council was rescinded, and the Society's examinations have been continued ever since, with some modifications. Thus for the present year the subjects of examination (for each of which separate certificates may be granted) were:—Arithmetic, English, book-keeping, commercial geography, shorthand, type-writing, French, German, Italian, Spanish, Portuguese, Russian, Danish, Chinese, Japanese, domestic economy, rudiments of music, and practice of music.

The examinations in these subjects, with the exception of that in vocal and instrumental music, were held on five successive evenings in March at 111 centres besides London, the total number of papers worked being 4,375 by 4,106 candidates. The practical examination in music was held at the Society's rooms in June, and was attended by 378 candidates.

I find from the Report of the City and Guilds of London Technical Institute, that the Examinations in Technology which they took over from the Society have been very largely developed. They include some sixty subjects; and last year were attended by 9,987 candidates. The subjects are:—Salt manufacture, alkali, soap, bread-making, brewing, spirit manufacture, coal-tar products, sugar manufacture, painters' colours, oils, &c., oils, fats, including candles, gas manufacture, iron and steel manufacture, paper manufacture, photography, pottery and porcelain, glass making, dressing of skins, leather tanning, boot and shoe manufacture, silk dyeing, wool dyeing, cotton dyeing, cotton and linen bleaching, calico and linen printing, wool and worsted spinning, cloth weaving, cotton spinning, cotton weaving, flax spinning, linen weaving, silk throwing and spinning, silk weaving, jute spinning, jute weaving, lace manufacture, framework knitting and hosiery, hat manufacture, telegraphy and telephony, electric lighting, electric lighting (preliminary), electro-metallurgy, metal plate work, plumbers' work, silversmiths' work, goldsmiths' work, watch and clock making, mechanical engineering, road carriage building, rail carriage building, typography, typography (preliminary), lithography, raising and preparation of ores, mine surveying, milling (flour manufacture), carpentry and joinery, ship carpentry, ship joinery, brickwork and masonry, plasterers' work, dressmaking, and cabinet-making.

The two examinations—those of the Society of Arts and those of the City and Guilds Institute—do not overlap. They are complementary, if I may so say, one of the other. Our examinations are literary and commercial. The Institute's examinations are in the Technology of trade and manufactures.

And now, if I may be permitted, like Mr. Barlow, of "Sandford and Merton" fame, to draw my moral; it would be that in looking for the effect of educational movements we must possess our souls in patience; and, secondly, that the time has not yet arrived for the Society to separate itself entirely from these educational movements, but rather to readjust its connection with them—at all events until it has some clear and definite and more essentially useful channel pointed out to it in which to turn its energies and resources.

Owing to a set of circumstances with which you are all, no doubt, so thoroughly conversant that I need not allude to them further, there was, shortly after the passing of the Technical Instruction Act, in 1889, a great windfall for technical instruction. Under the Customs and Excise Act of 1890, the residue, amounting to something over three-quarters of a million of money in England and Wales, became applicable to technical education. It has been so applied very largely. From a recent return it appears

—and I exclude Wales and Monmouth because the statistics are complicated there, owing to the money being also applicable to the purposes of the Intermediate Education Act—that of the forty-nine County Councils, forty-one are applying the whole, and eight a part of the residue to technical education. Of the sixty-one County Boroughs, fifty-three are applying the whole, and seven a part of the residue to technical education, while in one case only (the County Borough of Preston) the residue is being applied wholly to relief of rates. Further than this, ten County Boroughs are, in addition, levying a rate under the Technical Instruction Acts.

For the year 1893-94, the forty-nine County Councils have allocated about £465,000, and the county boroughs about £161,000 from the customs and excise grant, besides raising over £12,700 by rates. This makes a total of almost exactly £626,000 provided in England alone for technical instruction for the year, independent of the grants from the Science and Art Department.

It is purely at the option of local authorities whether they apply the "beer" money to technical education, or whether they use it in relief of the rates. It is very gratifying to see the extent to which they have devoted it to the former object, and it shows that the operations of the Science and Art Department, the Society of Arts, the City and Guilds of London, and other bodies which had previously been engaged in the movement, have not been unfruitful. But unquestionably a great danger lurks around a sudden outburst of zeal of this kind. How far have the public generally been convinced of the efficacy of science and art and technical instruction, and the advantage of spending all this money on it, rather than in relief of rates? or how far have they been only momentarily carried away unwilling captives at the chariot wheels of the enthusiasts? How soon will the pendulum of public opinion which has been so suddenly and so severely forced in one direction swing back again? Or—a still greater danger—how soon will the critic, the cynic, and the "practical" man commence their innings by asking to have the account balanced and the profit shown? If I am not mistaken, there are already murmurings in the air: did not our forefathers get on very well without technical education? or how is it that we stand—or, at least, stood—at the head of manufacturing and commercial fame and engineering ability? At all events, if you cannot show any fruit let us have an inquiry—dig up the plant and have a look at its roots to see that we have planted the right sort.

Now what is this "technical instruction" with which the country is so much occupied at the present time? It is defined in the Act of 1889 as instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries or employments, as well as in modern languages and commercial and agricultural subjects, but not in teaching the practice of any trade, or industry, or employment.

Before passing from this definition it may be interesting to call attention, parenthetically, to the fact that in the first volume of the Transactions it is recorded that "the Society, desirous to improve the present mode of education, offered medals to masters of schools for teaching the greatest number of scholars to speak Latin correctly and fluently, and in like manner German, Spanish, and Italian languages, not usually taught at schools in England."

The Act in fact provides for instruction in Technology and not in Technics. But I suppose a Bill to promote instruction in Technology would have had rather too *outré* a sound. Besides, though the definition clause is careful to indicate that the principles of science and art are to be cultivated, the title of the Act appeals to the sympathy of the great mass who always clamour for a short cut—some way for arriving at the money-making application of science and of art without that preliminary study, which is so laborious and apparently unremunerative.

It is no doubt a fact that during the latter part of the last and the commencement of this century, invention and the application of science to manufactures made prodigious strides, for between 1765 and 1785, through the genius of Watt, Arkwright, Hayman, and Crompton, the steam-engine, the spinning jenny, the mule and the power loom came into use. And when one remembers what they had to contend with, and how badly, as far as scholastic instruction is concerned, they were armed for the contest, one cannot but be astounded at the victories won by the ability, the indomitable energy, and resolution of the great men—the inventors, the millwrights, the engineers—of those days. Some of them of the second generation, if I may so say, are still happily alive, and ready and active in providing for their

successors that instruction which they themselves managed to do without—but at what an expenditure of energy in working out for themselves problems which had already been solved and whieh, with a proper system of technical instruction, should have been common property.

The history of that time shows, in a striking way, how supply will follow demand in the most unexpected directions, and almost makes one believe that genius is irrepressible, and will overcome all obstacles. I suppose it will, and possibly will be strengthened by the struggle —if the possessor lives long enough. But we do not know—and never can know—how much talent, how much genius, has been lost to the world by the pure physical breakdown of the unfortunate possessors of exceptional ability who so often are in advance of their time; while a little help at the right moment, a little encouragement, and, still more, a little appreciation, would have preserved them for the good of the world. Technical education, whether of a scientific or artistic kind, will not create genius—will not make leaders of men and movements—but, at least, by diffusing knowledge, it should place the public generally in a better position to appreciate and use those gifted men when they arise.

In its very earliest days, the Society of Arts showed its just appreciation of the right course to pursue, in not confining its efforts to the education of the producer—but in extending it to that of the consumer. As was soon made evident by the Government schools of design, established by Mr. W. Ewart's Committee of the House of Commons in 1834, the question is not one simply of producing designers. What is the use of them, until the popular taste can appreciate good decorative work, or discriminate between it and that which is vulgar and bad. And, if intelligent appreciation is necessary to give mechanical invention, whose fruits appeal so directly to our material interests, a fair chance, how much more necessary is it in all that implies artistic treatment. Fine artistic perception is limited to the comparatively few; but who can prove to the rest of the world their ineptitude—their want of taste? If it concerned themselves only, there would be no particular reason for making the attempt; but the law of supply and demand is no less inexorable in matters æsthetic than in matters materialistic. There is plenty of fair artistic ability potential in the land, if only the demand for its products were sufficient and of the right kind; an artificial forcing of the supply is absolutely useless without the demand.

But why, it may be asked, is it necessary to educate people in such matters now any more than it was in the times when those works were produced that are generally admitted to be examples for study. The answer is surely obvious. There is, at the present time, no living traditional art—it is all a matter of eclecticism. There is no sound basis of criticism; but plenty of it with a strictly literary backbone. Now, do not misunderstand me, when I say there is no living art. I do not mean there are no living artists. Perhaps there are as great artists now as at any period. But they work in a very different environment. Take architecture, which, after all, must strike the key-note to all the arts of the day. During my lifetime we have been practising Classic, Gothic, Renaissance, Palladian, Italian, Jacobean, Queen Anne, and so on, while a few enthusiasts have brought in a spice of Mahommedan, Hindu, and Chinese. It is not my business to say which is right, or which is the best; they are all right in a sense. I only desire to call attention to the difference in the circumstances during, say, this century, and the time when the admitted masterpieces were produced. Then—at a definite period—a specific form or style of art pervaded a whole country; it had gradually been evolved from something that had gone before, and its evolution was proceeding, possibly, to something more vigorous, possibly, to decay; still, it was a living art. The art patron of the day did not, before giving his order, run first through the whole gamut of styles to make his selection. He knew he must take what he wanted in the style of the day, and be thankful if it was good of its kind—the kind was the canon and standard of criticism. The artist worked, appreciated, stimulated, and to some degree checked by an intelligent public opinion which had been educated and instructed by its surroundings in that particular style of art. How different to this is the practice of late times. It is a toss up what the style may be. The work of the artist, instead of being spontaneous, is more or less an archæological study. It is criticised as often as not for its style rather than for its goodness as an example of that style. The general public shrugs its shoulders, wonders what it is all about, and when something will be invented which, if lauded to the skies by some, will not be de-

nounced as a monstrosity and an eyesore by at least an equal number of the art *cognoscenti*.

Let me give you an instance. I daresay several of those present can recall to mind the onslaught made on the design selected for the monument of the Duke of Wellington in St. Paul's, which was surmounted by an effigy of the Duke on horseback. The attack was led by perhaps the ablest periodical of the day as far as literary ability went, which had Gothic proclivities. The climax was reached in a remark attributed to a dignitary of the Church, as to his inability to understand how a man could ride on horseback on the top of his own coffin. Alfred Stevens who, by the way, was some time master of the School of Design in Sheffield, is now generally admitted to be one of the greatest, if not the greatest, sculptor and original decorative artist that England ever produced, and the monument is, I believe, shortly to have the horse and rider provided for it according to the original design.

Under these circumstances is it to be wondered at that there are constantly violent fluctuations of opinion—that every now and then we hear a great outcry against the Royal Academy and its schools or South Kensington and its "system." And if South Kensington now why not in a few years hence the technical schools and courses of instruction which are being set up with so much care and thought in all parts of the country? I am sure this danger is already felt by many who are interested in technical instruction. The Science and Art Department could always point to the fact that, if its science teaching was wrong, it erred in good company, for the syllabuses were prepared, and the examinations were conducted by some of the most eminent men of science of the day. If its art training was wrong, it was that which had been laid down by some of the most accomplished artists of the day; it was watched and reported on by such from year to year; and the so-called "system" was, for the matter of that, no invention of South Kensington, but the plan on which artists had been taught their trade from time immemorial.

But to whom can the local authorities under the Technical Instruction Act appeal? It seems to me that for their own satisfaction, and for the future stability of technical instruction, they will desire, instead of remaining as it were isolated and self-contained, to have an influential examining and inspecting board, to which they might refer, if they found it desirable, for assistance and advice. There are at present several bodies partially covering the ground—but only partially, such matters, for instance, as the art industries, which have been largely taken up by County Councils, coming into nobody's parish; and there is the great disadvantage of a want of unity. This is not the moment to bring forward any detailed scheme. I desire now simply to throw out the suggestion that the Society of Arts, which is at present covering part of the field, should take the initiative in bringing all these bodies together, so that they may form some kind of joint board, or at least co-operate.

I have now concluded my subject: but though it is not usual, I believe, for the Chairman's address to contain obituary notices, I should not like to let this opportunity pass without for one moment dwelling on the loss the Society has met with in the past year in the death of two of its active members. I allude to Lord Alfred Churchill, for many years a member of Council, and at one time its Chairman, and to my old friend and colleague, Sir Philip Cunliffe-Owen, sometime Director of the South Kensington Museum—whose eminent services in connection with international exhibitions are so well known.

It is now my pleasant duty to present the Society's silver medals which have been awarded during the last session.

For papers at the Ordinary Meetings:—

To Lewis H. Isaacs, for his paper on "Carriage-way Pavements for large Cities."

This valuable paper which contains a full account of the various modes of paving the roads of large cities attracted a large amount of attention and elicited a very important discussion.

To W. Worby Beaumont, for his paper on "Automatic Balance of Reciprocating Machinery, and the Prevention of Vibration."

Mr. Beaumont described in this paper a very ingenious method of preventing vibration in machinery, which is the result of much study of this very important subject on the part of the author.

To G. J. Symons, F.R.S., for his paper on "Rainfall Records in the British Isles."

The founder of the wide-spread system of rainfall records, described in this paper the present condition of the organisation which, without assistance from Government, has been established over the country.

To Prof. Vivian B. Lewes, for his paper on "London Coal Gas and its Enrichment."

Professor Lewes delivered a course of Cantor lectures on this subject last year, and he has continued the account of the progress made in this successful attempt to improve the illuminating power of our gas supply.

To CHAPMAN JONES, for his paper on "Some Recent Developments of Photographic Chemistry."

Mr. Chapman Jones has done original work for the advancement of photographic chemistry; and in this paper he discussed the varions methods and processes employed for the development and manipulation of the silver image.

In the Indian Section :—

To JOHN A. GRAY, for his paper on "Experiences at the Court of Afghanistan."

Mr. Gray's account of his experiences in the service of the Amir Abdurrahman has given us a considerable insight into the condition of a country, respecting which so little is known by Englishmen.

To SIR AUCKLAND COLVIN, K.C.S.I., K.C.M.G., C.I.E., for his paper on "Municipal and Village Water Supply and Sanitation in the North-West Provinces and Oudh."

The late Lieutenant-Governor of the North-West Provinces has done good service to the cause of sanitation in India by the information on the condition of one of the divisions of that continent given in this valuable paper.

To C. S. LECKIE, for his paper on "The Commerce of Siam, in Relation to the Trade of the British Empire."

Mr. Leckie is a resident at Bangkok, and eminently qualified to inform us as to the importance of Siam to British trade. He favoured us with this paper during a short visit to this country.

In the Foreign and Colonial Section :—

To EDOUARD SÈVE, for his paper on "The Antwerp Exhibition, 1894."

Mons. Sève, Vice-Consul for Belgium, has given in his paper a valuable account of the arts and industries of Belgium, and he strongly urged British manufacturers to participate in the Exhibition, which was held at Antwerp, during the summer and autumn of the present year.

To JAMES INGLIS, for his paper on "New South Wales."

The present condition of the trade of the colony of New South Wales is fully set forth in this paper by Mr. Inglis, who holds the office of President of the Sydney Chamber of Commerce.

In the Applied Art Section :—

To PERCY FITZGERALD, M.A., for his paper on "The Adam Architecture in London."

Mr. Fitzgerald has given in this paper an exhaustive account of the work of Robert Adam, the famous architect whose name will always be honoured in this place.

To HENRY BALFOUR, M.A., for his paper on "The Evolution of Decorative Art."

Mr. Balfour has given us the result of some important researches into the history of the growth of design.

To J. STARKIE GARDNER, for his paper on "Pewter."

The subject of the domestic use of pewter is one of considerable interest, and Mr. Gardner has added in this paper another to his valuable series of papers on metal work.

Thanks were voted by the Council to Mr. W. H. Preece, C.B., F.R.S., for his paper on "Electric Signalling without Wires."

Sir RICHARD WEBSTER, G.C.M.G., Q.C., M.P., proposed a vote of thanks to Sir John Donnelly for the admirable manner in which he had discharged his duty as Chairman of the Council that evening, and for the extremely valuable paper he had read. In it he had traced in the most attractive manner, and with chronological accuracy, the work of the Society from its foundation, and had pointed out how it had been necessary, from time to time, for the Council and members to mould and shape its operations, to meet the requirements of the day. In early days, the meetings and operations of the Society had to supply the place subsequently filled by the Royal Academy; it was also true that other societies had sprung from it; and it would be idle to regret that any branch of its work should be taken up from time to time by younger organisations. On the contrary, they ought to be glad to think that any seed sown by the Society had led to such good fruit, and that the art, industry, or science had shown sufficient vitality to start for itself its own independent organisation. The address had also pointed their minds to the probable or possible development of the Society's work. The Chairman had shown with clearness and force the connection between technical education and the work of the Society, and how there had come upon them during the last five or six years as an outcome of the original outburst of education due to the Primary Education Act of 1870, this laudable desire for technical instruction. Surely this opened to their minds a vista of useful work in the future. He was delighted to be able to support the statement made in the paper as to the valuable work which had been done by the Society in the maintenance of its examinations. The Council had had to consider for some time whether or

not the work in this direction was not to a certain extent rendered unnecessary by other organisations; but they had come to the conclusion that it was necessary, and he was satisfied that the experience of the last few years had confirmed them in the opinion that that judgment was right. Sir John Donnelly had called attention to the fact that throughout the length and breadth of the land, in villages and small towns, as well as in the populous centres, there had been this sudden outburst of the desire for technical instruction. Surely what he had pointed out, as a possible further work of the Society, showed a sphere in which the work of the Society might be continued with increasing energy and the greatest possible utility. He was quite satisfied that although some of the older members of the Society might feel that from time to time it was absolutely necessary for the work to be remodelled; for its members to be prepared to undertake new experiments, some of which would not be successful—for no society could be always successful—but some of which no doubt would be useful; and, recognising that demand on their energies, and the necessity of meeting modern requirements, there would no be lack of useful work to do. On the contrary, he believed that, though it might be necessary in some measure to depart from their old methods, the ever-increasing and laudable ambition of men and women to enlarge the sphere of their knowledge, and to obtain opportunities for accurate training, would always afford the Society scope for valuable work. This paper was one of those monuments set up from time to time by the wayside, which would enable future chairmen to take stock, and see how far the Society was fulfilling in time to come the promise and ambition of the past. This record was a fitting opening for the Session's work, and he had much pleasure in moving the vote of thanks.

Sir HENRY DOULTON, in seconding the motion, said this interesting record of the history of the Society was calculated to encourage all who had taken any part in its work. The Society had done much in preparing the ground and sowing the seed from which others had reaped the harvest. Much of the work had been pioneering work, and the community had reaped the advantage. Sir John had indicated some lines for the future, and he was sure they would prosecute the work in the future in the same spirit in which it had been carried on in the past.

The motion having been carried.

The CHAIRMAN, in responding, said it was very gratifying to find that the suggestion he had thrown out at the end of the paper had already met with such powerful support. He trusted the Council might be able to take it up and carry it a step further, but of course its success depended not on the Society, but upon the good will of the local authorities all over the country.

Miscellaneous.

EXHIBITION OF PHOTOGRAPHY.

The Executive Council of the Imperial Institute have announced that a special exhibition of photography in its applications to the arts, sciences, and industries will be held at the Imperial Institute, in connection with the United Kingdom Section, during the summer season of 1895. An influential committee of advice has been formed, composed of governors of the Imperial Institute and scientific men of well-known standing who are interested in photography; and sub-committees have been appointed in connection with the seven sections of the exhibition, viz.:—

Division 1.—The history of photography, including illustrations of early processes, the progressive development of processes, the early processes of photo-mechanical work, and modern photographic literature.

Division 2.—Artistic photography, comprising a thoroughly representative exhibition of all schools, embracing known as well as new works, and illustrations of the present condition of photographic art in the various colonies and in India.

Division 3.—Photography as an industry, demonstrating the apparatus used in photography and the special processes connected with the preparation of lenses, the production of brass fittings, cameras, &c., shown in actual production; the preparation of dry plates, coating of sensitive media, printing processes, also shown in actual operation; reproduction of pictures, and the production of portraits by daylight and artificial light.

Division 4.—Photography in its applications to industries, such as reproductions having photography as their basis, as applied to illustrated journalism, literature, &c., and industrial applications of photography to ornamentation.

Division 5.—Applications of photography to the sciences, including orthochromatics, optics, stereoscopy, photomicrography, spectroscopy, meteorology, and magnetism, astronomy, automatic recording apparatus, &c.

Division 6.—Applications of photography to educational purposes.

Division 7.—Miscellaneous applications of photography, including applications of photography to architecture and archæology, to engineering, to military and naval purposes, to legal purposes (such as the detection of forgeries), to surveying, cartography, chronography, &c.

Notification of the exhibition will shortly be transmitted to the principal firms engaged in the manufacture of apparatus connected with photography in the United Kingdom. The Governor-General of India, the Governor-General of the Dominion of Canada, and the Governors of the various colonies have, by a recent mail, been requested to invite Indian and colonial manufacturers to exhibit.

THE PRODUCTION OF TEA IN JAPAN.

The United States Consul at Nagasaki, says that in that *Ken*, tea cultivation is conducted as follows:—On inclined ground the tea is planted in furrows, but on level ground the plants are grown separately. The space between each row is about three and a half feet. On the hill sides it is planted in rows, but on the plains and near the houses it is grown in circular patches. After the first and second leaves are picked the branches are cut with shears. The object in cutting is mostly to make the plant round or semi-circular. Formerly the plant was cut down to the ground every three years. The ground is cultivated three or four times in the spring, summer, and autumn. The grasses are cut, and manure applied twice a year—in spring and in autumn. For manure, night soil, green weeds, accumulated soil, oil cakes, and fish, are used. These manures are used only for plants near people's residences; for those on the hill sides, weedings are performed twice a year, in spring and in autumn, and the weeds are used as manure. The season for gathering first tea buds or leaves begins on the first or second of May, but in some localities first leaves are gathered about the 20th of May. Second buds or leaves are generally allowed to grow, unless the market price is very high, or the first leaves gathered are found much smaller than usual. In the vicinity of Omura and Hirado, however, they gather both first and second leaves. In picking leaves for the best tea, three tender leaves are picked together; for the middle and lower classes of tea, five leaves are picked at once; and for the lowest, all the young leaves are gathered. In picking leaves women are usually employed. The average quantity of the three leaves picked by a woman is from ten to thirteen catties a day (a catty is equivalent to 1·31 pounds avoirdupois). The manufacture was formerly conducted in two ways, namely by drying in the iron pan, or in the sun, then drying in paper utensils was introduced, and more recently, drying in bamboo baskets came into vogue The method of drying in the iron pan is still extensively used. For manufacturing black tea, the Indian method was formerly followed, but at present the Chinese method is adopted. For sorting tea leaves, heated in paper utensils, round and square sieves are used, and for rolling utensils, either case, or bag is used. Night soil, oil cake, dried fish, green grass, and weeds, are considered the best manure for tea plants. The hours of labour are from 5 in the morning until 6 in the evening. The daily product per man is as follows:—With the iron pan, about thirty catties; with the paper utensil, about twenty catties; with the bamboo basket, about forty-five catties. The women are employed only at steaming the tea leaves, and are paid only half the rate of the payment to the men. When the season arrives, the workmen are hired daily, the farmers helping each other. In Omura, contracts are made beforehand by advancing money about January or February.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian Lewes, "Explosives and their Modern Development." (Lecture I.)

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. A. Newsholme, "Nature of Nuisances, including Nuisances the abatement of which is difficult."

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Mr. William Ireland, "A New Machine for Making Nets." 2. Mr. George Thomson, "An Improved Pneumatic Valve Closet."

Imperial Institute, South Kensington, S.W., 8½ p.m. Dr. R. Bowdler Sharpe, "More Curiosities of Bird Life."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. A. Dudley Clarke, "The Incidence of Taxation on Land."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Walter B. Harris, "A Journey to Tafilet, Morocco."

Actuaries, Staples-inn-hall, Holborn, 7 p.m.

Camera Club, Charing Cross-road, W.C., 8¼ p.m. Capt. C. H. W. Donovan, "Matabele War Notes."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. C. V. Boys, "The Newtonian Constant of Gravitation, or Weighing the Earth."

TUESDAY, Nov. 27...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Albert J. Durston's paper, "The Machinery of War Ships."

Photographic, 50, Great Russell-street, W.C., 8 p.m. (Technical Meeting.) 1. Mr. A. Pringle, "An Arrangement devised by Mr. C. E. Hearson for keeping Developing Solutions at a Fixed Temperature." 2. Mr. A. Pringle, "A Simple Apparatus for Testing the Speed of Shutters, with examples." 3. Discussion on Mr. Warnerke's paper, "Chromatic Photography."

WEDNESDAY, Nov. 28 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Hiram Maxim, "Experiments in Aeronautics."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Prof. A. Bostock Hill, "Trade Nuisances."

Royal Society of Literature, 20, Hanover-square, W., 8½ p.m. Opening Meeting of the Session. Mr. Percy W. Ames, "Positivism in Literature."

British Astronomical, University College, W.C., 5 p.m.

THURSDAY, Nov. 29...Antiquaries, Burlington-house, W. 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Sir Joseph Barnby, "Contemporary Music."

Imperial Institute, South Kensington, S.W., 4½ p.m. Mr. A. Vandendriesche, "The Utilisation of the Agave as a Fibre-producing Plant."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. R. M. Simon, "Workers in Copper, Zinc, Brass, and Tin."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. H. H. O'Farrell, "From Far to Near East."

FRIDAY, Nov. 30...Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Prof. A. Wynter Blyth, "Sanitary Law."

Royal, Burlington-house, W., 4 p.m. Annual Meeting.

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FRIDAY, NOVEMBER 30, 1894.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ELECTRICAL TREATMENT OF SEWAGE.

In consequence of Mons. Hermite's inability to attend on Wednesday, December 5th, the paper on the "Electrical Treatment of Sewage," arranged for reading on that evening, is unavoidably postponed, and a paper on "Fire Protection," by Edwin O. Sachs will be read in its place.

CANTOR LECTURES.

On Monday evening, 26th inst., Professor Vivian B. Lewes delivered the first lecture of his course on "Modern Developments in Explosives."

The lectures will be printed in the *Journal* during the Christmas recess.

FOREIGN AND COLONIAL SECTION.

A meeting of the Committee of this Section was held on Thursday, 22nd inst., at 4 p.m. Present :—Sir Charles M. Kennedy, K.C.M.G., C.B., in the chair, Lord Belhaven and Stenton, Hyde Clarke, Francis Cobb, Admiral Sir E. Ommanney, C.B., F.R.S., Sir Westby B. Perceval, K.C.M.G., P. L. Simmonds, with Sir Henry Trueman Wood, Secretary to the Society, and Edward Cunliffe - Owen, Secretary to the Committee. The programme of papers to be read during the present Session was discussed.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

The final meeting of the Royal Commission was held on Monday, 26th inst., at 4 p.m. Present :—Major-General Sir John Donnelly, K.C.B. (chairman), in the chair ; Sir Frederick Abel, Bart., K.C.B., D.C.L., Captain W. de W. Abney, C.B., F.R.S., William Anderson, D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., G. Ledgard Bristow, Michael Carteighe, Sir George Hayter Chubb, Francis Cobb, J. Biddulph Martin, M.A., Sir Westby B. Perceval, K.C.M.G., William H. Preece, C.B., F.R.S., Sir Owen Roberts, F.S.A., M.A., Prof. W. C. Roberts-Austen, C.B., F.R.S., Alexander Siemens, Sir Richard Webster, G.C.M.G., Q.C., M.P., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, November 28, 1894 ; Sir Richard Webster, G.C.M.G., Q.C., M.P., in the chair.

The following candidates were proposed for election as members of the Society :—

Brocklehurst, George William, Rock-house, Sydenham-hill, S.E.

Elmes, Sidney W., 62, Sydney-street, South Kensington, S.W.

Fox, Francis Douglas, M.A., 28, Victoria-street, Westminster, S.W., and Coombe-springs, Kingston-on-Thames, Surrey.

Fulton-Smith, James, 14, Museum-street, Warrington.

Jeckell, Joseph Alexander, South Shields.

Parnacott, Alfred, The Ferns, Penge, S.E.

Switzer, Sidney A., 28, Queen-street, Horncastle, Lincolnshire.

Thomson, George, Woodhouse-hill, Huddersfield.

Unwin, Philip Ibotson, Lordswood-lodge, Harborne, Birmingham.

Wethered, Thomas Arthur, Marlow, Bucks, and Grand Hotel, Puerto Arotava, Teneriffe.

Winby, Frederick Charles, 47, Portland-place, W., W., and 11, Clement's-lane, E.C.

The paper read was—

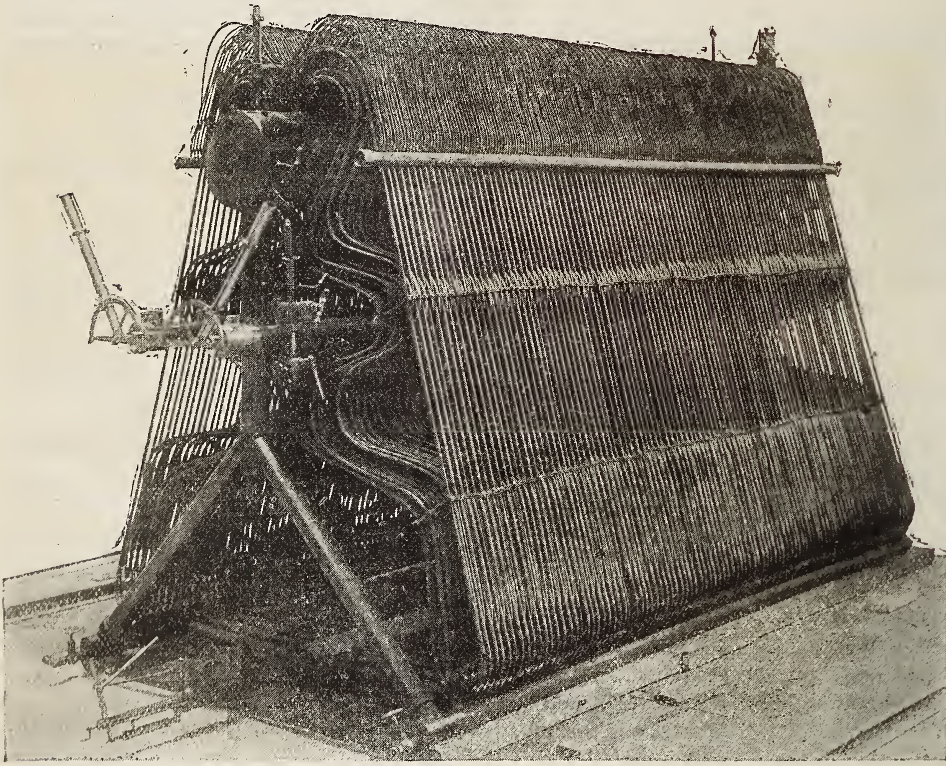
EXPERIMENTS IN AERONAUTICS.

By Hiram S. Maxim.

In the winter of 1856-57, when I was sixteen years of age, my father worked out a plan of a flying machine. It consisted of a small platform which he proposed to lift directly into the

air by the action of two screw-propellers revolving in reverse directions. One of the screw-propellers was to be placed about 10 ft. above the other, and the shaft of the lower one was to be tubular, and made to rotate on the outside of the shaft driving the upper screw. He had studied out a system by which the relative action of the two screws could be changed, so as to prevent the machine from rotating in either direction. For a motor, he proposed to employ some kind of an explosive material, gunpowder preferred, but I distinctly remember that he said if an apparatus could be successfully navigated through the air, it would be of such inestimable value as a military engine that no matter how much it might cost to run it, it would be used by Governments, even if the engines had to be driven by an explosive as costly as fulminate of mercury. A year or two later, the well known Peter Cooper, of New York, actually commenced a series of experiments with a view of

Fig. 1.



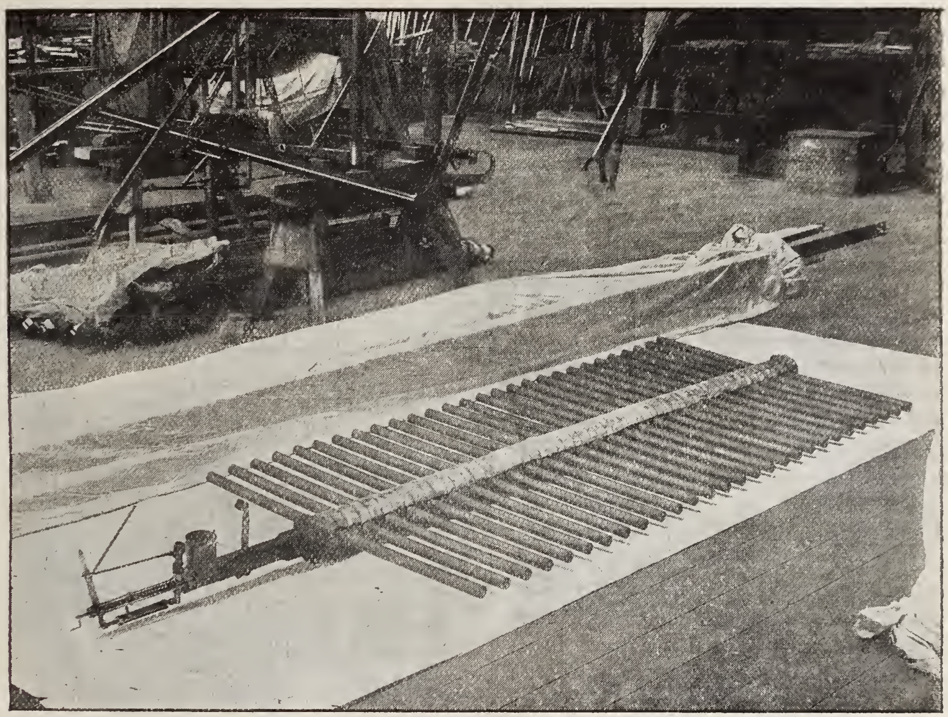
The Boiler, the Feed-water Heater, and the Burner.

constructing a machine to lift itself directly into the air by means of screw-propellers on vertical shafts. He proposed to drive his screws by means of engines utilising the explosive force of chloride of nitrogen. I do not know how he proposed to handle so sensitive and dangerous a compound, but from what I have learned from his grandchildren, I believe he intended to produce the explosive as consumed. However, he had not gone very far with his experiments when a premature explosion injured the sight of one of his eyes, and he then seems to have abandoned the whole thing.

I believe that almost everyone, when they commence to study the question of aerial navigation by means of machines heavier than the air, first think of lifting the machine directly into the air, either by the agency of wings or by screw propellers working on vertical shafts. I remember some twenty years ago, when I myself commenced to think of the subject, that my first idea was to lift my machine by vertical propellers,

and I actually commenced drawings, and made calculations for a machine on this plan, using an oil motor something like a Brayton engine for my motive power. However, I was completely unable to work out any system which would not be too heavy to lift itself directly into the air, and it was only when I commenced to study the aeroplane system that it became apparent to me that it would be possible to make a machine light enough and powerful enough to raise itself without the agency of a balloon. From the very first I was convinced that it would be quite out of the question to employ a balloon in any form. No matter from what point the question was considered, I always found that if a balloon was large enough to be of any practical value in lifting a machine, it would be large enough to prevent its progress through the air. A flying machine to be of any value must of necessity be able to propel itself through the air at a velocity greater than that of an ordinary high wind; it ought at least to be able to travel at

Fig. 2.



The Burner and the Apparatus for injecting Air.

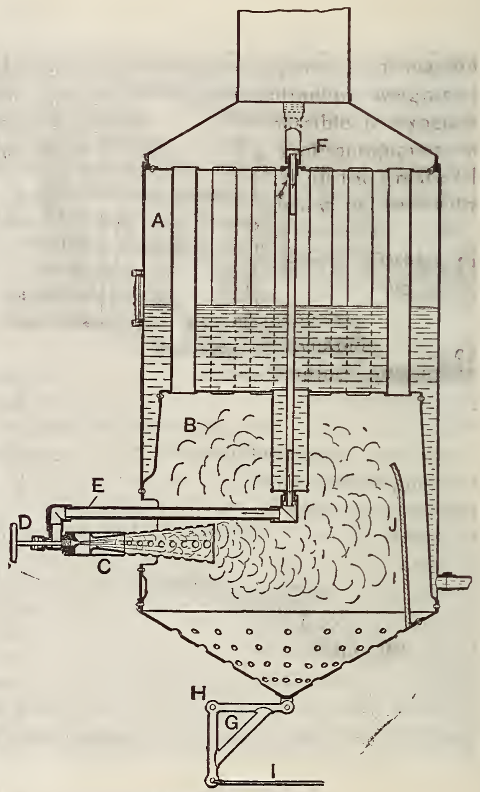
a velocity of thirty-five miles an hour. At this speed I found that a small and cheap aeroplane would lift more for its weight than a balloon, and would require vastly less to propel it. Therefore, in an actual flying machine, the balloon appeared to me to be, not only useless, but impossible. If large machines could be made with sufficient power to lift themselves vertically into the air, experimenting with them would be comparatively simple, because no large field would be required, but with the aeroplane system, which may be considered a kite, or perhaps a system of kites, and which must rise at an angle, it is necessary that the machine should have a long run in order to attain the required velocity for rising, otherwise it would be necessary to find some place where a strong gale could be relied upon, when the machine might be anchored to the earth and be flown in the air after the manner of a kite. I ascertained that there were cañons in California where a forty mile gale, always in the same direction, could be relied upon in the afternoon nearly every day in the

year. I determined to obtain a place in one of these cañons and to construct my machine after the manner of a big kite, having one or more aeroplanes. I should have anchored it to the top of a tall post, and commenced my experiments by flying it without any motor. The first experiments would be with the steering apparatus, and not until I should be able to maintain the apparatus in the air on an even keel, and at the exact height of the post to which it was anchored, would any experiments be made with the motors. A dynamometer would be introduced into the wire ropes securing the machine to the top of the post. This would indicate the tendency to drift with the wind, while the lifting power of the machine could be easily tested by attaching weights. In this manner it would be possible to experiment with all sorts and sizes of aeroplanes, and to ascertain which would lift the greatest load and have the least tendency to drift with the wind. The next experiment would be with the engines and propellers. When the machine was raised in the air, the engines could be started and the screw-thrust accurately determined by the dynamometer before referred to. When the engines and propellers had been so perfected as to completely slacken the rope which held the machine against the wind, it might be considered that the machine was actually flying. This is about as simple and as effective a system of experimenting with a machine of this kind as could be imagined, but I was unable to go to California, and had to content myself by conducting experiments in England.

As I could not rely upon the wind to raise my machine, it was necessary for me to drive it through the air, and for this purpose I procured a large field, 1,800 feet broad, where I laid down a light railway track on which my experiments have been conducted.

In regard to motors, as before stated, I first studied the oil-engine. Brayton's motor was the first oil or gas-engine ever produced which gave fair results, and it may be considered as the parent of all the recent economical engines using internal combustion. I was, however, at that time unable to design an oil-engine which was light enough for the purpose. The next one considered, and the one which has always figured out much lighter than any others, was a naphtha engine in which naphtha instead of water was used in the boiler. The experiments of those very able engineers, Messrs. Yarrow, have clearly demonstrated that a great deal more work per unit of heat may be developed by the use of naphtha than by the use of water in the generator, because a much less quantity of heat is carried over in the exhaust. Moreover, the temperature is much lower, and as there is no tendency to rust, very light steel tubes may be used in the generator. But the element of danger was so great that I was forced to abandon this idea. The next motor to be considered was a steam-engine, and this is the motor which I am employing to-day. I commenced my motor experiments with a view of ascertaining how much water could be

Figs. 3.



The Gas Generator.

evaporated from small copper tubes, and having obtained a quantity of these, $\frac{3}{8}$ in. external diameter and $\frac{1}{50}$ in. thick, I mounted four of them in a white hot furnace, and found that I could evaporate $26\frac{1}{2}$ lbs. of water per hour from a square foot of heating surface, that the tubes would stand more than a ton pressure per square inch when cold, and that under steam pressure they only burst at 1,650 lbs. pressure per square inch. I also found that with a forced circulation, although the quantity of water passing was very small, but positive, there was no danger of overheat-

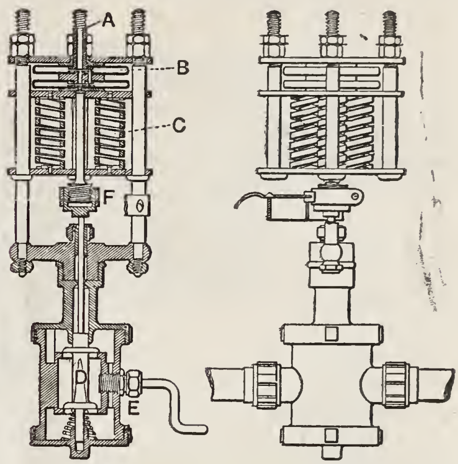
ing, even with the hottest kind of a fire. I next made a boiler 8 feet long, $4\frac{1}{2}$ feet wide, and 6 feet high, having, altogether, about 800 square feet of heating surface. The weight of this boiler, with its feed-water heater, its casing, the dome and the smoke-stack and connections was very nearly 1,000 lbs. It was first tested with a cold-water pressure of 410 lbs. to the square inch, and then with a steam pressure of 330 lbs. to the square inch.

Having completed my boiler, the next step was to experiment with a gas generator and burner. One of the first burners which I used was made almost entirely of sheet nickel, but this became so very brittle after running a few days that it was quite impossible to use it. I then made a steel burner similar to the one shown. The first burner had many more tubes, and no less than 14,000 jets. One half of these tubes were removed and the rest shortened, when much better results were obtained. After considerable experimenting, I found that common naphtha, 72° Beaumé, was the most suitable for fuel.

The gas generator consists of a small vertical boiler made of very thin and strong steel, all the joints being silver-soldered. This generator is constructed in such a manner that a certain portion of the tube sheets is flexible. A central hollow stay-bolt is provided with a valve, and adjusted in such a manner that when the pressure in the generator is less than 50 lbs. per square inch, a portion of the gas passes downward through the stay-bolt, and escaping through a species of Bunsen burner, furnishes the heat for generating the gas. The generator is therefore heated by a portion of its own contents. In case the pressure should rise above 50 lbs. per square inch, the tube sheets will be sprung outward, the valve closed, and the gas supplying the heat shut off. The pressure is therefore automatically regulated in a very simple and efficient manner. The generator is mounted on a bell-crank lever and supported by a spiral spring. When the weight of naphtha in the generator is less than 40 lbs. per square inch, the generator is raised, which operates on a mechanism which shortens the throw of the naphtha pump at each stroke. This apparatus is found to work admirably, and no matter whether a large or a small quantity of gas is being consumed, the weight of naphtha in the generator never varies more than a pound. The gas from the generator is superheated by passing through the fire-box of the boiler; it then passes through a regulating valve, and finally through an adjustable jet, where its force is employed to draw in a large quantity of air, which becomes thoroughly mixed with the vapours before they escape through the burners. The holes in the burner pipes are so placed and arranged that one jet strikes another at such an angle as to prevent them from being blown out, and, at the same time, induce a strong current of air from the bottom. This furnishes the necessary draught, without the aid of a fan-blower or steam jet.

The steam-engines are made, for the most part, of a high grade of steel, many of the parts being tempered. There are two high-pressure cylinders each 5 in. in diameter, and two low-pressure cylinders each 8 in. in diameter; they are double acting, and all

Figs. 4 and 5.



Steam Pressure Regulator.

have a common stroke of 12 in. The steam pressure used is from 275 lbs. to 320 lbs. per square inch, and the number of revolutions is from 300 to 400 per minute. It is found, by experiment, that the boiler is able to make a great deal more steam than the engines are able to consume. A by-pass is provided which admits of allowing the high-pressure steam to pass directly into the low-pressure cylinder. In passing through a species of injector, a fall of about 200 lbs. in pressure is made to do work on the surrounding steam in such a manner that the direct pressure in the low-pressure cylinder is increased to considerably more than the back pressure on the high-pressure piston.

Before completing my large machine, I conducted a series of experiments on a much

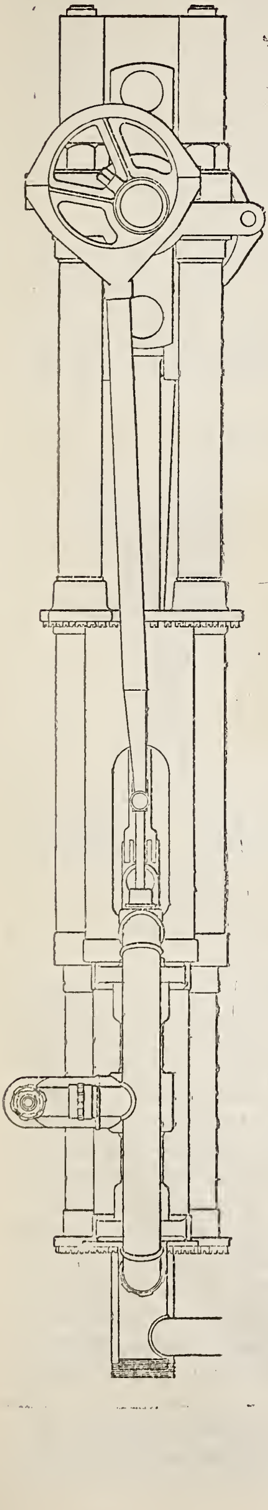


Fig. 6.– Side Elevation of the Engine.

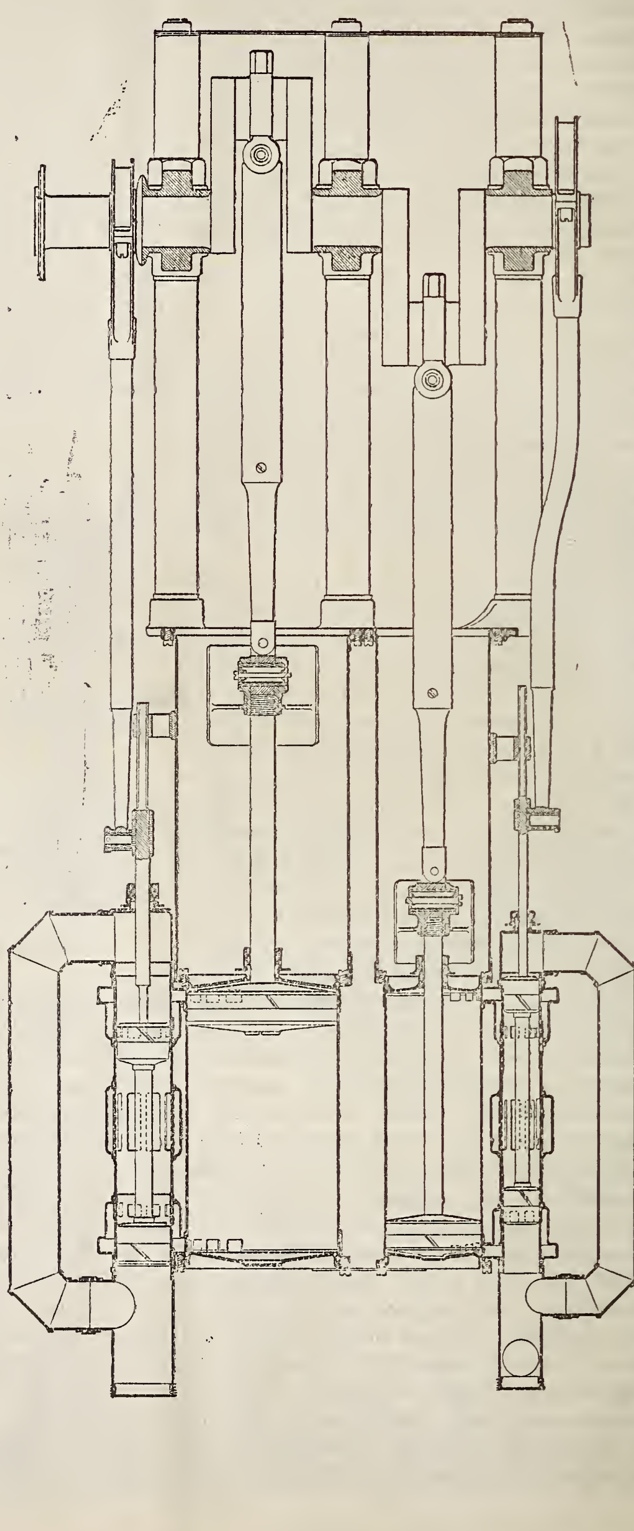
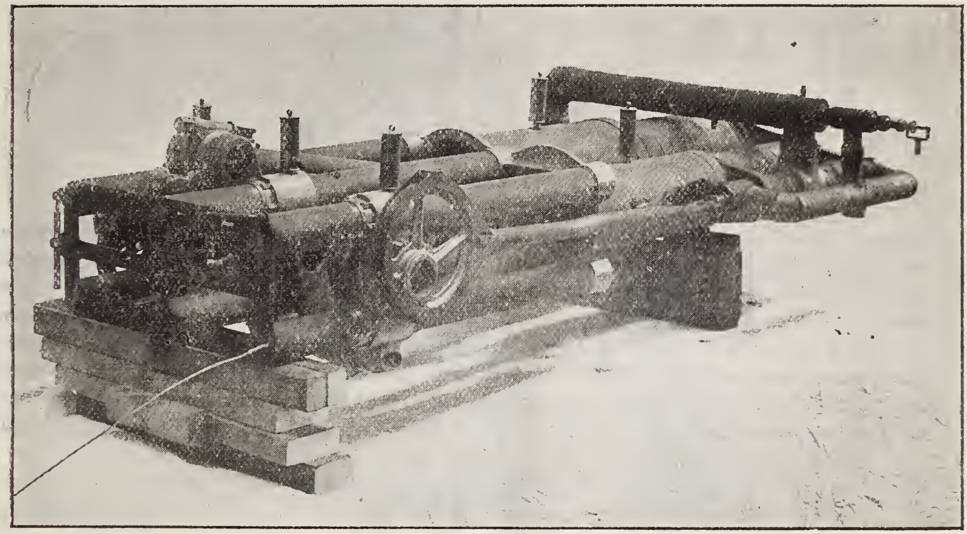


Fig. 7.—Horizontal Section of the Engine.

smaller scale with an apparatus similar to that employed by Professor Langley in his well known experiments. At the time, however, I did not know that Professor Langley was making any experiments, and my apparatus was constructed quite independently of his. The results of our experiments are very nearly alike. I mounted a long arm on a central pivot, the length of the arm being sufficient to make the circumference of the circle around which it travelled exactly 200 feet. To the end of this arm I attached a small apparatus, and transmitted power to it through the central pivot and the radial arm. This apparatus was constructed in such a manner that it enabled me to ascertain with a great degree of nicety the exact power required to drive the plane through the air, the lift of the plane, the thrust of the screw, the slip of the screw, &c. A great many forms of screws were employed in these experiments, some being plain, some with increasing pitch, and some with a compound increasing pitch. In a screw propeller, working in water, the best results are obtained when the points of the blades are made rather narrow, but with a screw running in the air, where the skin friction is so small a factor that it need not be considered, there is a decided disadvantage in reducing the width of the ends of the blades. The results of my experiments have shown that a well made screw is a fairly efficient aerial propeller.

Fig. 8.



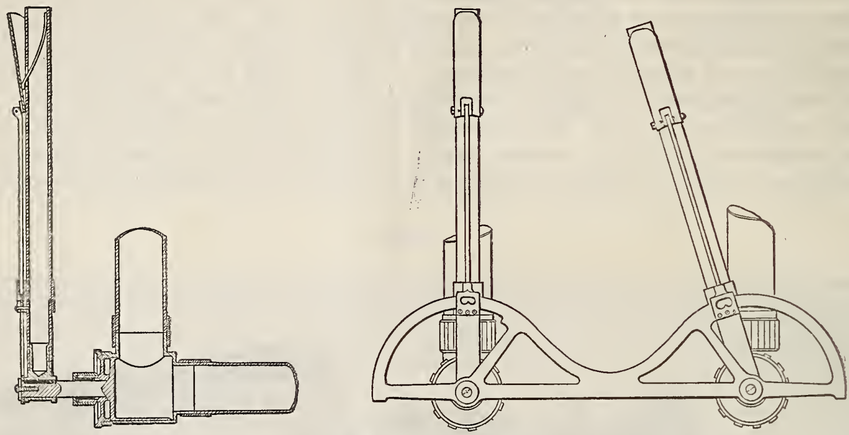
The Engine in Perspective.

The large screws which I employ in my machine are 17 ft. 10 in. diameter, and have a pitch of 16 ft. The width of the blade at the tip is about 5 ft. The weight of the screws is 135 lbs. each before painting, and I have applied as much as 180 horse-power to one of these screws.

A great many experiments were also made with different forms of aeroplanes, and it was found that as much as 133 lbs. could be carried with the expenditure of one horse-power with a well-made aeroplane. Long and relatively narrow planes were found to be more efficient than very large ones, and superposed planes were found to work well provided they were not placed too near together. With very narrow superposed planes, I have found that it is possible to lift a very large load per square foot, but if the planes are arranged one above the other, it requires a good deal of power to drive them through the air. Suppose, for instance, that the planes should be $\frac{1}{10}$ in. thick, and be placed 2 in. apart, and that they were driven through the air at the rate of 40 miles an hour. The planes occupying one-twentieth part of the whole space would either have to drive the air, in which they were travelling, forward at the rate of two miles an hour, or the air would have to be spun out, and pass through the spaces between the aeroplanes at the rate of 42 miles an hour as relates to the planes. I

have found this arrangement to be so wasteful in power as to give very narrow superposed planes little or no advantage over well made large planes placed in such a position as not to cause this particular action on the air. However, narrow planes may be advantageously employed, provided they are made very thin, and, instead of being superposed one immediately over the other, are arranged after the manner of a flight of stairs, or zig-zag, that is, in such a manner that the air is able to pass freely

Fig 9.

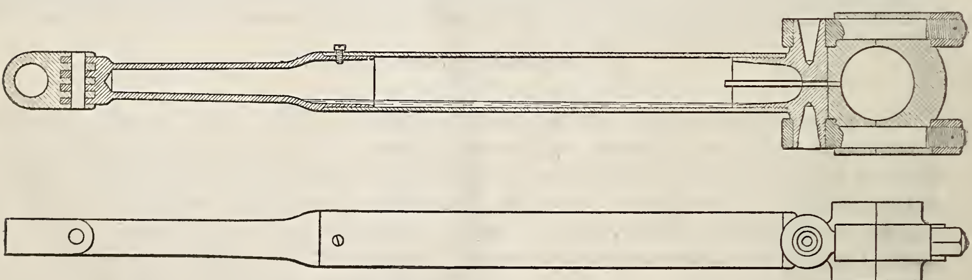


The Throttle Valves.

between them when they are being driven forward, the arrangement being such that the sum of all the spaces is nearly equal to the total area occupied by all the planes. In this way I am able to obtain a large lifting effect per square foot, and at the same time greatly reduce the amount of power necessary to drive the planes through the air.

Notwithstanding that my first experiments on a small scale demonstrated conclusively that small and narrow planes were somewhat more efficient than large ones, I determined to use very large aeroplanes on my machine at least with my first experiments. No matter how efficient the small superposed, inclined, or zig-zag aeroplanes might be while travelling

Figs. 10 and 11.



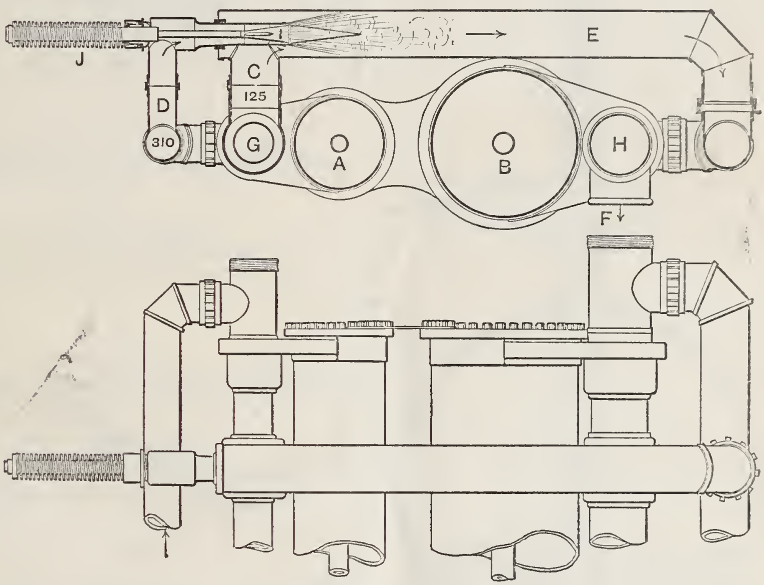
The Connecting Rods.

through the air at a high velocity, their resistance against falling in case of a stoppage or a breakdown of the machinery would not be anything like as efficient as a very large plane. It will be easy to understand that if a machine is provided with a very large plane, in case of a stoppage, the whole apparatus becomes, as it were, a parachute, and a very rapid and destructive fall to the earth is absolutely impossible.

All my experiments went to show that an aeroplane in order to be efficient must be very rigid, and not be deformed by the pressure of the air, and I found that it was not at first

an easy matter to make a large aeroplane which would fulfil all the requirements. After a great many experiments, I constructed an aeroplane, the framework of which consists of very strong but thin steel tubes stayed with strong steel wires. The underneath side of this framework I covered with a fine quality of balloon material, slightly varnished, but not sufficiently to prevent a small quantity of air from passing through. The top side of the framework was covered with the same material, but varnished sufficiently to make it absolutely air-tight. The bottom was stretched very taut over the whole surface, and was only held to the frame at the edges and by two lines through the centre, while the top was drawn over the framework rather loosely and secured to it not only at the edges, but also in parallel lines about six feet apart. The fore and aft rudders are covered in a similar manner. As the aeroplane is run rapidly forward, a certain portion of the air passes through the underneath side and sets up a pressure between the upper and lower coverings. The top side takes the load and bags upward between the supports. This forms corrugations in a longitudinal direction, which offer no perceptible resistance to the air, whereas the bottom, by having practically the same pressure on both sides, is not distorted in the least. This aeroplane is found to be nearly as efficient as it would be if cut out of a solid piece of wood. Both the fore and aft edges are made exceedingly sharp, the cloth being laced together over a thin but strong wire. The figure of the main aeroplane is, approximately, octagonal.

Figs. 12 and 13.

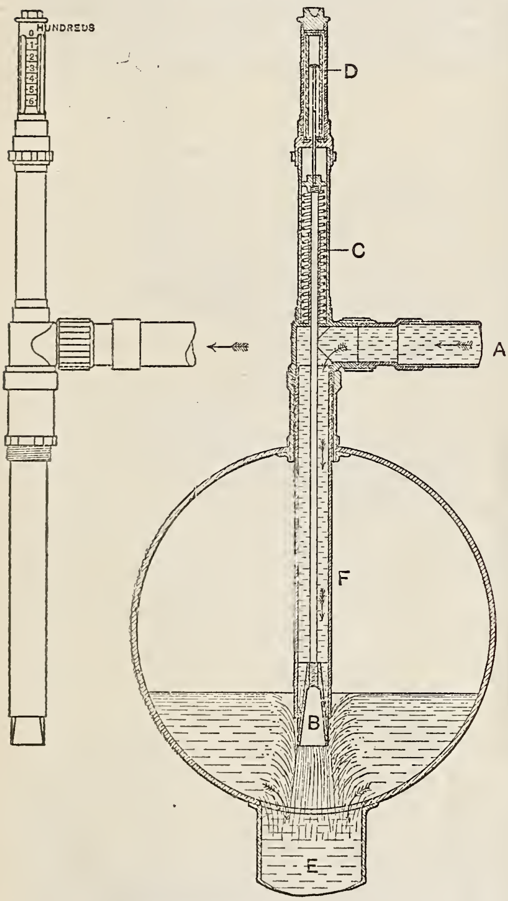


The High Pressure By-pass.

In my early experiments, I generally placed my aeroplanes at an angle of 1 in 14; that is, at such an angle that in passing ahead 14 inches, they pressed the air down one inch. I find it more convenient to express the angle in this manner than in degrees. With a well-made and very smooth aeroplane placed at this angle, I can rely upon a lifting effect of 14 lbs. for every pound of screw thrust imparted to the aeroplane, the skin friction being so small as to be negligible. With a large machine, however, and only a short railway track, I decided to mount my aeroplanes at an angle of 1 in 8, so as to get a large lifting effect with a relatively low speed. When my large machine was finished it was found to weigh very nearly 8,000 lbs. while standing still, with the men, the water, and the fuel on board; but when run over the track with a steam pressure of about 275 lbs. per square inch, the weight on the track became *nil*. It will be understood that these experiments are being made on a railway track, which consists of ordinary light steel rails about 8 ft. gauge. Outside and above these rails is another

track of 3 in. by 9 in. Georgia pine, the gauge being about 30 ft. The machine is provided with two complete sets of wheels, one for running on the lower steel rails, and the other for engaging the wooden track when the lower wheels have been lifted one inch clear of the steel rails. At a steam pressure of 275 lbs. per square inch, I found, in my last experiments that, after about 600 ft. of the track had been covered, that the

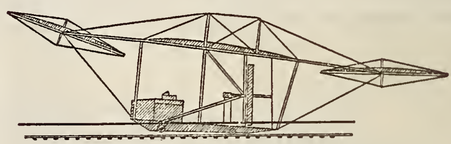
Figs. 14 and 15.



The Forced Circulation.

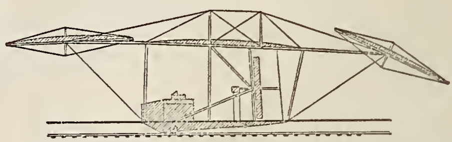
machine vibrated, running part of the time on the lower steel rails, and part of the time on the upper track. But when the steam pressure was increased to 320 lbs. per square inch, all four of the upper wheels were kept in constant contact with the upper track, and when about 1,000 ft. had been covered, the lifting effect became so great that the rear axletrees were doubled up, the rear end of the machine lifted up about 4 ft., and finally one of the front wheels tore up about 100 ft. of the upper track, when steam was shut off, and the machine dropped to the ground without any great shock. One of the timbers of the upper track lodged in the lower framework of the machine, causing considerable damage, but all the machinery, with the exception of one of the screws, escaped injury. At the time this accident occurred the screw thrust was about 2,000 lbs., and the engines were developing 362 horse-power. The boiler, however, was not running at its full capacity. The parts of

Fig. 16.



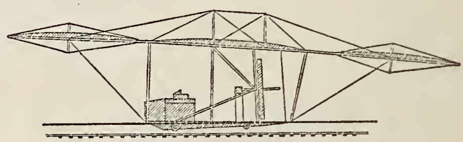
The Front Wheels off the Track.

Fig. 17.



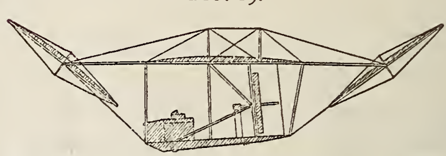
The Hind Wheels off the Track.

Fig. 18.



All of the Wheels off the Track.

Fig. 19.

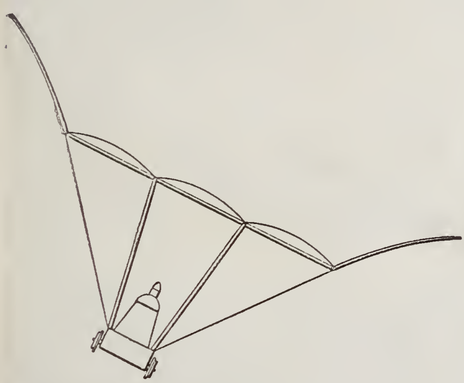


Position of Rudders to prevent Pitching while Falling.

the machine which were damaged on this occasion have now been repaired, and I am strengthening some of the stays and braces, so that in my next experiments, if I find it necessary, I can run the engines up to 400 horse-power, or even more; but in order to do so, I shall allow a certain amount of the live steam to pass directly into the low-pressure cylinders, as before referred to, so as not to allow the boiler pressure to mount to more than 300 lbs. to the square inch.

The machine is provided with a fore and aft rudder, both of which are connected to the same windlass. If the front rudder is placed at an angle considerably greater than that of the main aeroplane, and the rear rudder placed flat so as not to lift at all, and the machine run over the track at a high speed, the front wheels will be lifted from the steel rails leaving the rear wheels on the rails. If the rudders are placed in the reversed position so that the front rudder is thrown out of action and the rear rudder lifts to its full extent, the hind wheels will be lifted from the steel rails leaving only the forward wheels touching. If both rudders are placed at such an angle that they both lift and the machine is run at a very high velocity, all four of the wheels will be lifted from the steel rails. This would seem to show that these rudders are efficient as far as vertical steering is concerned. If the machine should break down in the air it would be necessary to tilt the rudders in the position shown in the illustration, when it would fall to the ground without pitching or diving.

FIG. 20.



THE SIDE WINGS PREVENT THE MACHINE FROM ROLLING.

In regard to the stability of the machine, the centre of weight is much below the centre of lifting effect; moreover, the upper wings are set at such an angle that whenever the machine tilts to the right or to the left, the lifting effect is increased on the lower side and diminished on the higher side. This simple arrangement makes the machine automatic so far as rolling is concerned. I am of the opinion that whenever flying machines come into use it will be necessary to steer them in a vertical direction by means of an automatic steering gear controlled by a gyroscope.

Many have supposed that the condensation of steam would present insurmountable obstacles to the use of a steam-engine on a flying machine. The surface condenser, as used for marine purposes, consists of a box nearly filled with a multitude of small tubes. Water, the cooling agent, is pumped into one end of this box, and discharged at the other through relatively small openings. A condenser made on this plan would be very inefficient, because the actual volume of air required to condense the steam is about 2,400 times as great as the volume of water required. The tubes of an atmospheric condenser, instead of being arranged in dense and compact masses, have to be spread out over a great deal of surface, and, instead of having air pumped through them, the tubes themselves are driven through the air. I have found it to be advantageous to make the tubes in the form of very thin aeroplanes, and to drive them edgewise through the air; in this manner an enormous volume of cold air is encountered. No air that has been heated by one tube ever touches another tube; moreover, the heating surface over which the same air passes does not exceed two inches in width. With a condenser properly made and arranged, I find that the air will not only condense all the steam into water sufficiently cold to be pumped, but it will also exert a lifting effect on the condenser considerably greater than the weight of the condenser and its contents. When the condenser is placed immediately after the propellers, the slip of the screws may be added to the speed of the machine; for instance, if the machine be travelling through the air at the rate of 50 miles an hour, and the slip of the screws be 15 miles an hour, the air would be driven through the blades of the condenser at the rate of 65 miles an hour. At this speed the cooling effect is very great. I have not yet finished my condenser experiments, but as far as I have gone, I feel sure that a copper condenser can be so constructed that it will return its own weight in water every five minutes, or if aluminium is used, every two and a-half minutes.

As to the weight of the motor complete, including 200 lbs. of water in the boiler and 600 lbs. in the condenser and tank, I think I may safely assert that it need not be more than 11 lbs. per horse-power, that is, if the steam-engine is employed. If, however, a special internal combustion engine should be designed, it would of course require less weight of water and condenser; in this case the weight could probably be reduced to

about 9 lbs. per horse-power. One pound of naphtha will generate about as much steam as two pounds of coal, and it would probably require rather more than a pound per hour to run a steam-engine, but with the internal combustion engine it is well known that one pound of fuel will develop one horse-power for one hour.

In Professor Langley's experiments, he succeeded in carrying as much as 250 lbs. per horse-power with very small planes mounted at a very slight angle, and driven at an exceedingly high speed. In my early experiments I used aeroplanes 20 to 100 times as large as those employed by Professor Langley. I mounted them at a steeper angle, and succeeded in carrying 133 lbs. to the horse-power, but in both cases the power referred to only relates to that which was actually required for driving the aeroplane itself through

Fig. 21.

A Group of Screws and other Objects Experimented with.

the air. When, however, it becomes necessary to drive the boiler and the engine, and a considerable amount of framework through the air, and when we have the slip of the screws to deal with, the amount of weight that may be carried with one horse-power is greatly reduced. With my large machine as first fiuished, the actual lifting effect was less than 28 lbs. per horse-power, but then this is the first large machine ever built, and is susceptible of many improvements, every one of which will increase the load which the machine will be able to carry with the expenditure of one horse-power. In designing a new machine, the advantages of my past experience will enable me to improve and simplify it, so that I shall be able to carry from 50 lbs. to 60 lbs. per horse-power; and I have no doubt that we shall shortly be able to carry as much as 100 lbs. to the horse-power. Even with only 50 lbs.,

a machine could travel from 250 to 300 miles and return to its point of departure, practically a flight of 500 to 600 miles.

Up to the present time my experiments have been conducted, for the most part, to ascertain whether it would be possible or not to

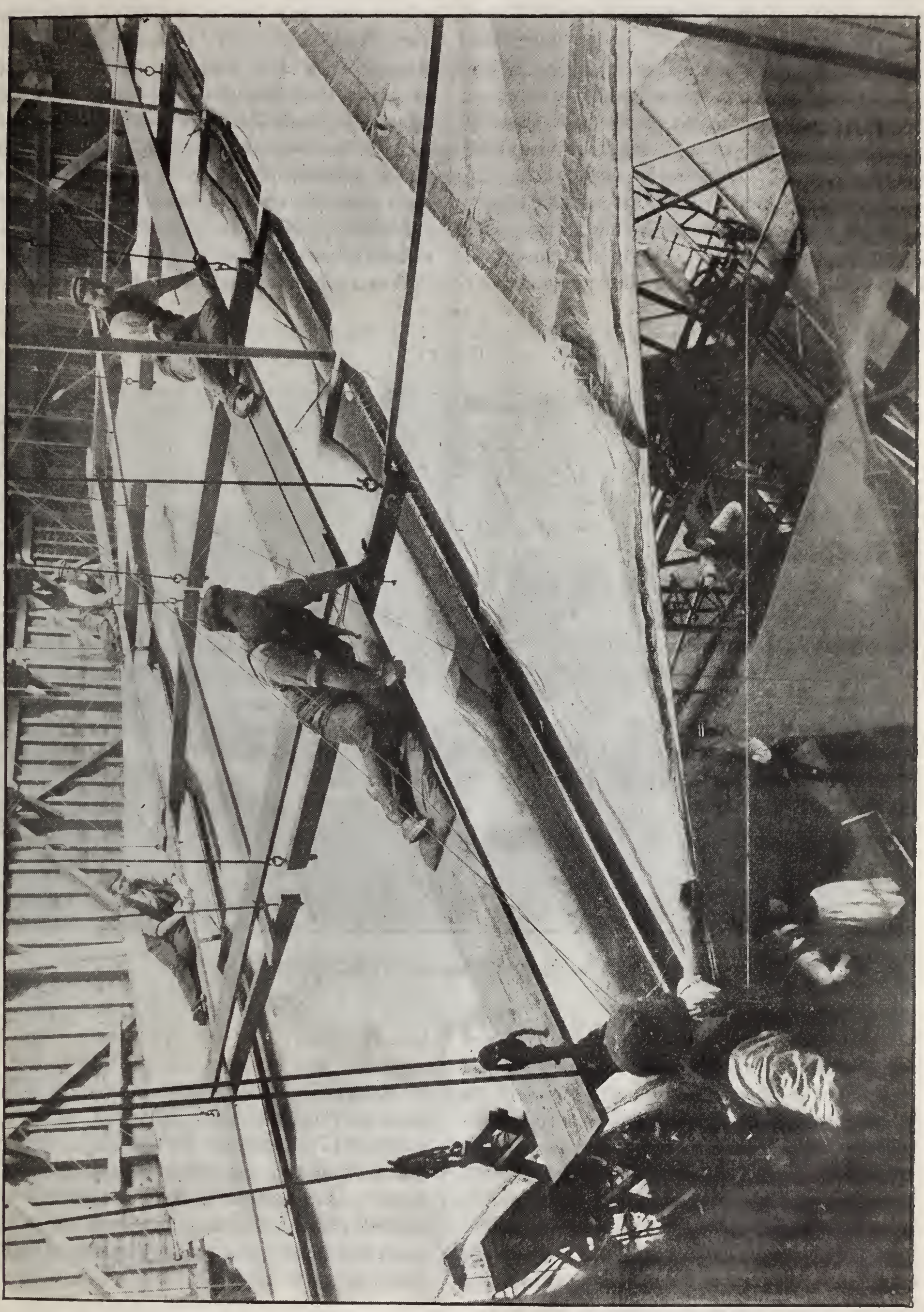


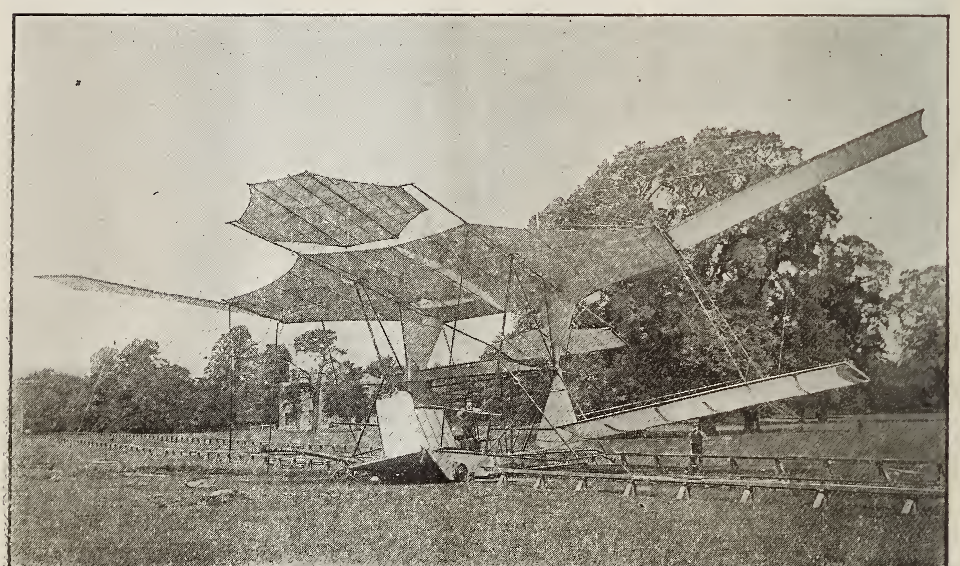
FIG. 22.—WORKMEN LACING THE TOP SIDE OF THE MAIN AEROPLANE.

construct a machine which would be powerful enough to raise itself into the air. When I commenced my experiments with automatic guns, the first time that the energy derived from one round loaded and fired the second round, I was certain that the automatic system

would be a success. Likewise, on the first occasion that my aerial apparatus lifted itself clear of the track by the energy of its own engines, I felt that the ultimate success of flying machines was assured. Several European governments have recently been experimenting with a view of navigating the air. It has long been known that if a machine could actually be made to fly at a velocity greater than that of the wind, it would be a most potent engine of war, and the nation first to make itself the master of the air would have an immense advantage over those less fortunate. Nearly all, however, have attempted to solve the question by improving the balloon, and, as a matter of fact, it has not been generally believed that a machine could be made to rise in the air without a gas bag. Now that it has been proved that a machine can be made to raise itself from the ground by its own energy after the manner of a bird, and that there is nothing whatever to prevent it travelling at a high velocity through the air, I think it will not be long before we shall have, at least, military flying machines. It will certainly not be more difficult to manœuvre and steer such machines than it is to control completely submerged torpedoes.

When the machine is once perfected, it will

Fig. 23.



Accident; the Machine Off the Track.

not require a railway track to enable it to get the necessary velocity to rise. A short run over a moderately level field will suffice. As far as landing is concerned, the aerial navigator will touch the ground while moving forward, and the machine will be brought to a state of rest by sliding on the ground for a short distance. In this manner very little shock will result, whereas if the machine is stopped in the air and allowed to fall directly to the earth without advancing, the shock, although not strong enough to be dangerous to life or limb, might be sufficient to disarrange or injure the machinery.

What now remains to be done is to study and develop the art of navigating the machine, but in order to do this it will be necessary to obtain larger premises free from trees and houses, and not until after it is possible to manœuvre the machine within a few feet of the ground should high or free flight be attempted. I have the utmost confidence that with the expenditure of a little more time and money, every difficulty will be overcome.

I would like to say a few words in regard to the efficiency of screw propellers working in the air.

When I began to investigate the subject,

I found that there were a great many opinions. Some engineers informed me that a screw propeller, on account of its fan blower action, would be very wasteful of energy, because it would draw in air at the centre and discharge it at the periphery. Upon experimenting, however, I found that it drew in air at the periphery and discharged it to the rearward.

Some engineers were of the opinion that, in considering the screw thrust, the projected area of the screw blades should be considered as a normal plane being thrust through the air at the rate of the slip, while others were of the opinion that the whole screw disc should be considered, and that the thrust would be equal to pushing a normal plane, equal to the screw disc, through the air at the velocity of the slip. Others again were of the opinion that the thrust of the screw would be about ·75 of such a normal plane.

The total area of my screw discs is very nearly 500 square feet, and the slip while running at 40 miles an hour is almost exactly 18 miles an hour. According to the first system of reasoning, in which only the projected area of the screw blades is considered, the thrust

FIG. 24.

THE MACHINE WITH ONLY THE MAIN AEROPLANE IN POSITION.

would be only 152 lbs.; while if we considered the whole disc, it would be 810 lbs., but, as a matter of fact, upon trying the experiment, I found the thrust to be 2,000 lbs.

When the machine was fastened to the track, and the screws run at such a speed that the product of the pitch multiplied by the number of turns was equal to 68 miles an hour, it was found that the screw thrust was 2,160 lbs. If we consider the projected area of the screw blades as normal planes with the wind blowing against them at a velocity of 68 miles an hour, we have a pressure of 2,173 lbs., which would seem to show that while the machine is standing still and all the energy goes into slip, that the first system of reasoning is correct, while the actual thrust when running depends altogether upon the speed: the higher the velocity the less per-centage of slip.

$$V^2 \times \cdot 500 = P,$$

$$(18^2 \times \cdot 500 \times 94 = 152 \cdot 28)$$

$$(18^2 \times \cdot 500 \times 500 = 810)$$

$$(68^2 \times \cdot 500 \times 94 = 2175 \cdot 28).$$

LIST OF ILLUSTRATIONS.

DISCUSSION.

The CHAIRMAN having invited questions,

Mr. DAVIS asked if Mr. Maxim could explain the theory of a bird's flight? He thought it would be as well to investigate this question before any large amount of money was spent in experiments. It was generally a good plan to go to nature, but, so far as he understood, Mr. Maxim was endeavouring to fly in the same way that a fish swam in the water. There were screw propellers for going through the water, and the same principle seemed to be adopted in this flying machine; but he did not think a bird propelled itself through the air by means of its tail.

Mr. JENKINS asked how the machine was steered in a horizontal direction, and what would be the effect of tipping in going round a corner? It seemed to him there would be a tendency to turn the machine over, and he should like to know if the side planes were capable of adjustment, so as to counteract that tendency?

Mr. WALTER REID asked what was the ultimate speed which it was hoped to attain by mechanical means? No doubt this was an important advance for military purposes, and he hardly knew whether they ought to wish Mr. Maxim success or not, because, if his machine were successful, it looked as if it would bring our nearest neighbour within an hour's distance.

Mr. LASCELLES-SCOTT said it seemed almost demonstrated, that it was possible by purely mechanical means to lift certain weights against the force of gravity, and to enable the machine and its contents to rise in the air; but in view of some researches which he had been studying within the last six months, the researches of Mr. J. W. Keeley, he was induced to believe that by the use of certain powers of mechanical and musical vibration it was possible to wholly or partially neutralise the force of gravity in various substances. It would be interesting to know what amount of speed Mr. Maxim thought he could attain as a matter of ordinary enterprise, say in passenger vessels, and, secondly, if it were possible to neutralise the weight of the machine by vibration upon the Keely system, what speed he would attain then.

Mr. MAXIM said before he took up this question

he thought something of the flight of birds and also something of terrestrial navigation. He had no doubt that if he turned his energies in that direction he might succeed in making a locomotive which would imitate the action of a man walking, and go perhaps four miles an hour; but there were plenty of men living who could make locomotives to go 60 miles an hour. It would be as foolish to try to imitate the flight of a bird as to imitate the walking of an animal on the ground. In a flying machine it was necessary to have an enormous amonnt of power at disposal, to be delivered in a continuous manner and always in the same direction. In the wings of a bird the movements were exceedingly complicated, and to imitate them the number of articulated joints would be enormous. Anybody attempting it would find the superstructure necessary to attach all the levers to, would weigh more than his machine. He did not know why the wheel for land locomotion and the screw for navigating the water or the air were not all that could be expected. When you drove a dog-cart along a street, and had to turn the corner of a street, it was necessary to make an abrupt angle, but when you got above the trees and houses—if you once got there—you could take as large a sweep as you liked. No doubt there would be a considerable amount of rolling, on account of currents of wind, and when the machine went round a circle, the greatest weight being below, the centrifugal action would throw it out, and that would bring the side wings automatically into the right position; it was not necessary to make them adjustable. With regard to the speed, he commenced modestly, and found that the lowest speed to which it was practical to lift the machine was 35 miles an hour; it was no use experimenting with a less speed than that, and everything considered he thought from 60 to 65 miles an hour would be the most suitable speed. Whatever he did, he had no doubt that as the machines were developed, if a number of smart men like Thorneycroft and Yarrow got hold of it after he had succeeded, they would very soon bring the speed up to 100 miles. Everything was in favour of high speed. The higher the speed the flatter the angle of the plane, and the greater the efficiency of the screw, because the screw was then working in undisturbed air, and the slip was not so large, relatively. With regard to Keely's motor, he did not suppose there was any man in England who know so much about it as himself. By a fortunate chain of circumstances he happened to find out all about it. It was suggested that some vibratory action would prevent the thing falling down; unfortunately, as far as flying was concerned, the force of gravity was a well-known fixed quantity; you could not change it, or make it pull in the opposite direction. He had a great many people writing him letters making various suggestions; some had found a way of reversing the action of gravitation, and making it pull up; a good many had suggested running the machine with a turbine, and using the same water over and over again—using an electromotor—an electromotor in which the current should be taken from the dynamo back to the motor again, and others had an ingenious device of unbalanced water and spiral springs enclosed in a box, which pushed more in one direction than in another. He wished he could get a vibratory apparatus which would be useful, but he was very much afraid that if he put it on the scale he would find that a pound of steel would still weigh exactly 16 ounces.

Mr. ANSON asked if Mr. Maxim thought he was the first who ever got a flying machine to rise?

Mr. MAXIM said that many years ago a Frenchman named Penaud succeeded in twisting a rubber spring, and making a thing somewhat like a butterfly, which went about 10 ft. in the air, flopped about, and fell down again; he presumed that was what the gentleman referred to. A good many experiments had been tried in various parts of the world, some in Russia, but he did not think they succeeded, and that the machine lifted itself. He thought Mr. Phillips, of Harrow, had done more than anyone else except himself in this direction. He was the only one who had experimented in a thoroughly scientific manner, and great credit was due to him. He made a machine with three wheels, which lifted two off the track, but his engines were not very perfect, and soon ran down; he did not make as much steam as he was using. But still he did prove something, and he did not know of anyone else who had done as well.

Mr. H. C. AHRBECKER said he must correct Mr. Maxim with regard to the Russian experiment. He supplied the engine, in 1880 or 1881, an illustration of which was given in *Engineering* on May 6th, 1881, and it did rise.

Mr. DAVIS said his question as to how birds flew had not been answered, and he still thought it was material and important.

The CHAIRMAN said the question might be interesting but it hardly came within the scope of the paper. In proposing a vote of thanks to Mr. Maxim, he would say that he had heard a great many papers in that room, but he had never heard one which contained more information or was more admirably put together. What struck him first about it was the exhaustive nature of the inquiry made by Mr. Maxim: he might be right, or he might be wrong, but he had left nothing in doubt; he tried each step as he went forward. To adopt his own simile, in endeavouring to make a machine to walk in the air, he had tried every joint before he allowed it to make a single step. What made this paper such an important one was that Mr. Maxim appeared

to have solved the minor points of difficulty, at any rate, and made the ground secure, so that others might go forward with the benefit of his experience. The next thing was that he had combined in his experiments both science and practice. He had not been content with saying — This scientific theory ought to act; planes on this angle ought to succeed; or some other device should be tried; but he had endeavoured to find out what the scientific theory of a flying machine should be, and then had shown, as far as he had gone, how to carry that scientific view into practice. With regard to Mr. Davis's question, he might say that there was another very marked departure in Mr. Maxim's discoveries. Those who had read accounts of flying machines in days gone by, would remember that they started from one of two sides, either to fly with the wings of a bird, the earliest attempt, according to classical story, being more than 2,000 years ago, and this had been tried again within the last 30 or 40 years, and proved an utter failure; and the other method was to utilise the lifting power of a balloon. The first thing Mr. Maxim had demonstrated was, that he could, by the power of the machinery, lift the machine's own weight, and drive it forward through the air by its action on the air. He hoped all present had followed the proof—so far as it went—of this fact. The machine left the rails on which it was running, and burst up the controlling rails, which should have kept it down. Whether or not he was the first to solve this problem he did not care to consider. His own opinion of the paper might be of little value from a scientific point of view, but he would remind the meeting that when Mr. Maxim described his invention before the British Association at Oxford, two of the greatest scientific men now living, Lord Kelvin and Lord Rayleigh, then expressed the opinion that Mr. Maxim by his discoveries had established the fundamental principles of a flying machine. He was quite satisfied that though there might be critics present who thought that Mr. Maxim was over-sanguine, or that others had, to a certain extent, solved the same problems, they would all agree that this paper was eminently deserving of their warmest thanks.

The vote of thanks having been carried unanimously,

Mr. Maxim said he was disappointed at not having more criticism. At the time he took up this subject it was almost considered a disgrace for anyone to think of it; it was quite out of the question, practically. But a good deal had been said in the public Press, both in England and the United States, during the last three or four years, about it, and at least nine people out of ten were of opinion that it would be possible to construct a flying machine, at least for warlike purposes — for reconnoitering, carrying explosive bombs into an enemy's country, and so on. England had control of the sea, and if they all put their shoulders to the wheel, notwithstanding the French and Russians spent a great deal more money than had ever been spent here, she might be able to have control of the air also. As long as he remained in England he should not forget that he was an Anglo-Saxon, and should try to do as much for navigating the air as others had done for navigating the water. He had been a member of the Society of Arts for many years, but this was the first paper he had the honour of reading there. He hoped it would not be the last, and that at some future time he would be able to describe to them the sensations of aerial flight.

Miscellaneous.

THE LIVE STOCK INDUSTRY OF TEXAS.

The sheep and cattle ranching industries of Texas are immense, the vast plains of the State affording unlimited pastures for both sheep and cattle, the only drawback being want of water. Of late, ranching has been less profitable than formerly, and to-day a well-stocked sheep or cattle ranch can be bought for very much less than a few years ago. Notwithstanding this depression the industry is a vast one, and the amount of capital invested is enormous. Consul Nugent, of Galveston, says in his last report that Texas stands at the head of the States of the Union in the number of live stock. There are more sheep, more cattle, more horses and mules, than in any other State or territory of the American Union. The total number of sheep in Texas in 1891, was 3,564,469, and in 1892, 3,366,257. The number has been decreasing for some years past, and the amount of wool clipped has diminished in proportion. In 1891, 2,978,459 sheep were sheared, yielding 15,499,979 lbs. of wool. In 1892, 2,539,054 sheep were sheared, the yield being 13,626,629 lbs. of wool. If the figures for 1888 were glanced at it would be found that no less than 3,860,034 sheep were sheared, the amount of wool clipped being 18,721,693 lbs. These figures show the great decrease at present in the sheep-ranching business. The Texan sheep are chiefly the Spanish Merino variety crossed with Mexican. Their average yield per head is about five pounds per annum. They generally run in herds of about 1,500. Cotswold, Southdown, and Leicester sheep, have from time to time been imported to try the effect of crossing them with the Texan sheep, but such experiments have never proved successful, as the imported sheep do not stand the climate, and will not "herd," as it is called. The number of cattle in Texas, although still greater than in any other State, has also decreased of late years. In 1891 the number was 6,856,338, and in 1892, 6,337,428. The stock is chiefly long-horned Texas cattle, greatly improved by crossing with imported Durham, Jersey, and Holstein bulls. Formerly, it was the custom to allow the cattle to

come to maturity in Texas, and then ship or drive them for sale, to Chicago. Nowadays they are taken when yearlings, to the Indian Territory, Montana, and Wyoming, as it has been found that they gain much more weight at maturity, when left for a year or two in the colder climate of the above-named States. The majority of the horses are of the kind known as "bronchos," the descendants of the wild horses of the plains, which stock is again derived from those brought over by Cortez. They are small, wiry, not much in appearance, but untiring and capable of covering great distances at their ordinary pace, which is a hand gallop or canter. There are of course many horses of other breeds in Texas, especially in and near towns, but the broncho is the Texan horse *par excellence.* In 1891 there were 1,452,306 horses and mules in the State, and in 1892, 1,690,135. In 1892 there were 12,972 donkeys, 268,390 goats, and 1,155,284 hogs in the State.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

DECEMBER 5.—"Fire Protection." By EDWIN O. SACHS. SIR DOUGLAS GALTON, K.C.B., F.R.S., will preside.

DECEMBER 12.—"Manufacture of Salt." By THOMAS WARD.

DECEMBER 19.—"Forestry." By LIEUT.-GEN. J. MICHAEL, C.S.I.

Papers for meetings after Christmas :—

"The Separation of Aluminium by the Vautin Process." By PROFESSOR WILLIAM CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. CHARLETON, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. CROMPTON, M.I.E.E.

"Tea." By A. G. STANTON.

"Improvements in Milling Machinery." By J. HARRISON CARTER.

"Electric Lighting of Ecclesiastical Buildings." By MAJOR-GENERAL CHARLES E. WEBBER, C.B.

"Cyder." By C. W. RADCLIFFE COOKE, M.P.

"Light Railways." By W. M. ACWORTH.

"Russian Armenia." By DR. A. MARKOFF.

"Madagascar." By CAPTAIN S. PASFIELD OLIVER.

"Commercial Education Abroad." By PROFESSOR WILLIAM LAYTON.

"The Lushais, and the Land they Live in." By CAPTAIN JOHN SHAKESPEAR.

"The Effects of Revenue Legislation on the Agricnlture of the Madras Presidency." By C. KRISHNA MENON.

"The Projected Railways of India, and their Prospects." By J. W. PARRY, A.M.Inst.C.E.

"Drawing for Process Reproduction." By GLEESON WHITE.

"Technical Carpet Designing." By ALEXANDER MILLAR.

"The Art of Casting Bronze and Copper in Japan." By W. GOWLAND.

"Our Food Supply from Australia." By E. MONTAGUE NELSON.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four or Eight o'clock :—

DECEMBER 6, at 4.30 p.m,—"Roman and British Indian Systems of Government." By the HON. W. LEE-WARNER, C.S.I.

*** This and two of the subsequent meetings will be held at the Imperial Institute.

January 17, February 14, March 7, 28, April 25, May 16.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four or Eight o'clock :—

January 22, February 19, March 5, April 2, 30, May 21.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

February 5, 26, March 19, April 23, May 7, 28.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock :—

PROFESSOR VIVIAN B. LEWES, "Modern Developments in Explosives." Four Lectures.

LECTURE II.—DECEMBER 3.—*Guncotton.*—The improvements which have taken place in its manufacture since its discovery by Schönbein—English service guncotton, and its manufacture — Nitroglycerine—Dynamite.

LECTURE III.—DECEMBER 10.—*Smokeless Powders.*—The early attempts to utilise guncotton, and the causes of their failure—The smokeless powders of to-day.

LECTURE IV.—DECEMBER 17.—*Blasting Explosives.*—Requirements —Fiery mines—A good safety explosive as great a safeguard as the safety-lamp—Explosives employed—The safety explosives now in use—Roburite, &c.

PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S., "The Arc Light." Three Lectures. January 14, 21, 28.

ALAN S. COLE, "Means for verifying Ancient Embroideries and Laces." Three Lectures. February 11, 18, 25.

DR. D. MORRIS, C.M.G., "Commercial Fibres." Three Lectures. March 18, 25, April 1.

JAMES DOUGLAS, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures. April 22, 29, May 6, 13.

ERNEST HART, D.C.L., "Japanese Art Industries." Two Lectures. May, 20, 27.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered by PROFESSOR C. VERNON BOYS, F.R.S., on "Waves and Ripples," on Wednesday evenings, January 2 and 9, 1895, at 7 p.m.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 3 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian Lewes, "Modern Developments in Explosives." (Lecture II.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Town-hall, Westminster, S.W., 7½ p.m. Mr. H. B. Ransom, "The Principles and Practice of Hydro-Extraction."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. E. W. Kuhn, "The Rational Sterilisation of Alimentary Liquids." 2. Dr. D. H. Attfield, "An Investigation of the Natural Sodium Sulphate Lakes of Wyoming, U.S.A." 3. "Specimens of Indiarubber, and Petroleum Oil, Varnish, and Soap," will be exhibited by Mr. Thomas Christy.

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. Oswald Brown, "Notes on Life in Australia."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. Louis Parkes, "Sanitary Laws and Regulations Governing the Metropolis."

British Architects, 9, Conduit-street, W., 8¼ p.m. "What steps can be taken to restore a proper appreciation of the Statutory Examination for Certificates of Competency to act as District Surveyor in London." Discussion opened by Mr. W. D. Caröe.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Mr. T. G. Pinches, "Semitic Languages."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Edmund Gosse, "The Literary Movement of the Century."

TUESDAY, DEC. 4...Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Statistical, Geological Museum, Jermyn-street, S.W., 4¾ p.m. Special Meeting. 1. Hon. Robert P. Porter, "The Eleventh United States Census." 2. Exhibition of the Hollerith Electrical Counting Machine by Dr. Herman Hollerith.

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. T. Manners Smith, "Some Points in the Anatomy of *Ornithorhynchus paradoxus*." 2. Mr. F. E. Beddard, "Certain Points in the Visceral Anatomy of *Ornithorhynchus*." 3. Prof. F. Jeffrey Bell, "Some remarkable Corals of great size from North-west Australia." Mr. G. A. Boulenger, "Second Report on Additions to the Lizard Collection in the Natural History Museum."

WEDNESDAY, DEC. 5... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Edwin O. Sachs, "Fire Protection."

Geological, Burlington-house, W., 8 p.m. 1. Prof. T. G. Bonney, "Supplementary Note on the Narborough District (Leicestershire)." 2. Mr. J. E. Marr, "The Tarns of Lakeland." 3. Mr. David Draper, "The Marble Beds of Natal." 4. Mr. J. Bridges Lee, "Description of a New Instrument for Surveying by the aid of Photography, with some Observations upon the Applicability of the Instrument to Geological Purposes."

Entomological, 11, Chandos-street, W., 7 p.m. 1. Col. Charles Swinhoe, "A List of the *Lepidoptera* of the Khasia Hills (Part III)." 2. Rev. T. A. Marshall, "A Monograph of British *Braconidæ* (Part VI)." 3. Mr. Charles J. Gahan, "The Longicorn *Coleoptera* of the West India Islands." 4. Mr. F. W. Urich. "Notes on the Fungus Growing and Heating Habit of *Sericomyrmex opacus*, Mayr." 5. Prof. E. B. Poulton, "An Apparent Case of Sexual Preference in a Mule Insect."

Obstetrical, 20, Hanover-square, W., 8 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, DEC. 6 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section). Hon. W. Lee-Warner, C.S.I., "Roman and British Indian Systems of Government." (This meeting will be held at the Imperial Institute.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Sir D. Brandis, "A New Revision of *Dipterocarpeæ*." 2. Mr. H. M. Bernard, "The Spinning Glands in *Phrynus*."

Chemical, Burlington-house, W., 8 p.m. 1. Ballot for Election of Fellows. 2. Mr. J. J. Buchanan, "The Use of the Globe in the Study of Crystallography." 3. Mr. H. Crompton, "Latent Heat of Fusion." 4. Mr. N. J. H. Fenton, "New Method of Preparing Dihydroxytartaric Acid." 5. Mr. A. C. Chapman, "Essential Oil of Hops."

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. Sydney Hickson, "The Fauua of the Rivers and Lakes."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Sir J. Crichton Brown, "Some Studies in Emotional Expression."

FRIDAY, DEC. 7 ... Geologists' Association, University College, W.C., 8 p.m. 1. Mr. A. Smith Woodward, "Notes on Megalosaurian Teeth, discovered by Mr. J. Alstone in the Portlandian of Aylesbury." 2. Mr. H. W. Monckton, "The Geology of the St. Gothard Pass."

Philological, University College, W.C., 8 p.m.

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, DEC. 8 ... Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

Journal of the Society of Arts.

No. 2,194. Vol. XLIII.

FRIDAY, DECEMBER 7, 1894.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 2 and 9, 1895, by Professor C. VERNON BOYS, F.R.S., on "Waves and Ripples."

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. The cards are now in course of issue.

CANTOR LECTURES.

Professor VIVIAN B. LEWES delivered the second lecture of his course on "Modern Developments in Explosives," on Monday evening, 3rd inst.

The lectures will be printed in the *Journal* during the Christmas recess.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, December 5, 1894; Sir DOUGLAS GALTON, K.C.B., D.C.L., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Dawson, W. Bruce, 102, Tyrwhitt-road, St. John's, S.E.
Parry, Richard, 27, Great George-street, S.W.
Weekley, George Mitchell, Thornbury, Hornsey-lane, N.

The following candidates were balloted for and duly elected members of the Society:—

Agabeg, Frank J., Sitarampore, Bengal, India.
Arthur, Matthew, Fullarton, Troon, Ayrshire.
Barnes, Charles Barritt, Florencedale, Selhurst-road, South Norwood, S.E.
Batalha-Reis, J., Portuguese Consulate, Newcastle-upon-Tyne.
Berkley, James Eustace, H.H. the Nizam's Guaranteed State Railways, Secunderabad, India.
Blenheim, William, Egham, Surrey.
Bourne, Charles William, M.A., King's College School, Strand, W.C.
Brett, Captain Walter Percival, R.E., Royal Military Academy, Woolwich, Kent.
Brousson, R. P., Geraldton, Sidcup, Kent.
Bynoe, Frederick Oatley, Gwendoline-house, Saltram-crescent, W., and 68, Cornhill, E.C.
Channon, Harry C., Cotswoldbury, Glengall-road, Woodford-green, Essex.
Christian, William, 21, Queen's-gardens, Hyde-park, W.
Cooze, A. W., Elvaston, Friern-park, North Finchley, N.
Craddock, Albert, 51, Weymouth-street, W.
Crawford, Archibald A., 1, Esplanade-road, Bombay, India.
Crewdson, Miss Gwendolen, The Barons, Reigate, Surrey.
Daw, Zacharias Williams, 11, Queen Victoria-street, E.C.
Denny, Thomas James, 95, Finsbury-pavement, E.C.
Desai, J. V., B.A., 19, Montem-road, Forest-hill, S.E.
Edwards, John, 4, Great Western-terrace, Glasgow.
Fearon, Henry Charles Digby, Stanhope-lodge, Herne-hill, S.E.
Ferguson, Alastair Mackenzie, Nanuoya, 14, Ellerdale-road, Hampstead, N.W.
Field, Frederick Arthur, Upper Marsh, Lambeth, S.E.
Fox, Charles, 104, Ritherdon-road, Upper Tooting, S.W., and Junior Constitutional Club, Piccadilly, W.
Fox, Charles Allen, M.R.C.S., Martock, Somersetshire.
Francomb, Richard Walker, Alderman, J.P., Wilderspool, Warrington.
Garland, James Allen, Lisburne Mines, Ystrad Meurig, R.S.O., Aberystwyth.
German, Major James, J.P., Belmont, Sevenoaks, Kent.
Green, W., 473, Oxford-street, W., and Pinnerwood-house, Pinner, Middlesex.
Greensill, Frank, 4, Windsor-terrace, Douglas, Isle of Man.
Hawkes, W. Clifford, 22, Old Steyne, Brighton.
Hepworth, Norris Rhodes, Torridon, Headingley-hill, Leeds.
Hiller, H. Croft, The Whins, Withington, Manchester.
Hindley, Charles Albert, 70, Welbeck-street, W.
Huard, Thomas, R.N., 125, Ilderton-road, Camberwell, S.E.
Inglis, Hon. James, Sydney, New South Wales.

Ironside, William Allan, 1, Gresham-buildings, E.C.

Kelly, William John, 43, King's-road, Camden-town, N.W.

Kilgallin, Charles J., 55, Marylebone-road, N.W.

Latham, Stanley A., 4, Essex-court, Temple, E.C.

Leaf, Arthur H., 9, St. Paul's-churchyard, E.C.

Lee-Warner, Hon. William, C.S.I., M.A., 4, Wilmington-gardens, Eastbourne.

Lewis, Henry Ryan, 7, Drapers'-gardens, E.C.

Lowdon, David, 23, Kingsland-crescent, Barry Docks, Barry, Glamorganshire.

Malvern, Thomas, 2, Rothsay-villas, Leighton-road, Cheltenham.

Müller, Henry Adolphus, 3, North-road, Entally, Calcutta, India.

Oke, Francis Robert, 5, Coppenhall-terrace, Crewe, Cheshire.

O'Shaughnessy, R. G., Bangalore, India.

Pace, Thomas Richard, 14, The Chase, Clapham-common, S.W.

Pain, James Charles, jun., Manhattan, Streatham, S.W.

Parry, Joseph W., Northolt, Blythe-road, Bromley, Kent.

Porter, Edmund Vernon, 44, Manor-road, Beckenham, Kent.

Rawes, Lieut.-Colonel William Woodward, R.A., Junior United Service Club, S.W.

Restler, James William, Southwark and Vauxhall Water Company, Southwark-bridge-road, S.E.

Robinson, William Leckie, The Elms, Coventry.

Roget, John Lewis, M.A., 5, Randolph-crescent, Maida-hill, W.

Simmelkjœr, Sophus, 8, Pemberton-gardens, Upper Holloway, N.

Spriggs, Joseph, Foxton, near Market Harborough.

Squirrell, Henry Thomas, 5, Station-road, Bexhill-on-Sea.

Standen, Joseph Henry, Broadlands, Streatham, S.W.

Suys, Jos, D.Sc., Hertford County College, Silesia-house, High Barnet, N.

Swinton, Alan Archibald Campbell, 66, Victoria-street, S.W.

Sykes, Clement Moriscrip, Kutch Mandvi, Kutch, India.

Thomas, John, 18, Wood-street, E.C.

Tottenham, Charles, 1, Grosvenor-place, S.W.

Travers, Major John Amory, Dorney-house, Weybridge, Surrey.

Upton, Lionel, The Stock Exchange, E.C.

Walkley, William Henry, 265, Kentish-town-road, N.W.

Walter, Louis H., 56, Victoria-street, S.W.

Whitehead, Percy, Barton Pines, near Paignton, Devonshire.

Wilson, Sidney, King's Land, Sayers-common, Hurstpierpoint, Sussex.

The paper read was—

FIRE PROTECTION.

By Edwin O. Sachs.

What is Fire Protection?

I should first explain what I understand fire protection to be. The term is, I am afraid, too often misunderstood. Fire extinguishing, in other words fire brigade work, is what the majority have in their mind, and many towns consider themselves well protected if they can boast of an efficiently manned fire-engine establishment. In reality the fire brigade as such has but a minor *rôle* in a rational system of protection. Really well protected towns owe their position in the first place to properly applied preventive legislation based on the practical experience and research of architects, engineers, and fire experts.

Fire protection, as I understand it, is a combination of fire prevention, fire combating, and fire research. Under the heading fire prevention, I class all preventive measures including the training of the public, and under the heading fire combating, I class both self-help and outside help.

Preventive measures may be partly contained in the Local Building Act, and partly in a separate code of fire-survey regulations, if necessary supplemented by special rules as to the treatment of extraordinary risks such as the storage of petroleum, the manufacture of explosives and the performance of plays. The training of the public I speak of may be simply such as can be quite informally commenced at school and then continued by official or semi-official warnings, and a judicious arrangement with the ever powerful Press as to the tendency of their fire reports.

I am not speaking in the abstract, as such forms of training have already been successfully introduced. I know of towns where the authorities have, for instance, had some of the meaningless fables of the Board School "Standard Reader" replaced by more instructive ones, which warn children not to play with matches, and teach them to run for help in case of an emergency. There are quite a number of municipalities where regular warnings are issued, to take an instance again, every December, as to the dangerous Christmas-tree. In such places every inhabitant has at least an opportunity of learning how to throw a bucket of water properly, and the neatest way to trip up a burning woman and roll her up without fanning the flames. The householder is officially informed

where the nearest fire-call point is, and how long he must expect to wait till the first engine can reach his house. If he is a newspaper reader he will also have ample opportunity of knowing the resources of his town, and the local reporter's fire report will give him much useful information based on facts or hints supplied by the authorities.

I said I classed both self-help and outside help under my heading "fire combating."

The self-help I speak of mainly affects the protection of large risks such as factories, stores, public places of amusement, where it lends itself to regulation. The requirements of the fire-survey code may allow for the arrangement of hydrants in certain risks, and also for their regular inspection, and the means for self-help may be thus given. These means will, however, probably not be properly made use of unless some of the *employés* engaged on the risk are posted in their purpose, and have confidence in everything at their disposal. The possibility of proper self-help in dangerous risks may be encouraged by enforcing regular drills for the *employés*, and regular inspections as to their efficiency. There are towns where great reliance is placed on the efforts of such amateur firemen. In some cities they even receive extra pay, and are formed into units, properly uniformed and equipped, and retained by the fire brigade as a reserve force for great emergencies

Self-help for the shopkeeper, the lodger, or the private householder, can scarcely be regulated. The opportunities I mentioned a few minutes ago under the heading of public training would already assure an intelligent behaviour on the part of a large percentage of this community. I know places where, without any regulation being attempted, and thanks entirely to the influence referred to, most residences can boast of a hand-pump, a bucket, and a crowbar, the proper use of which is known to most of the household. Self-help in small risks may, however, be distinctly encouraged by the authorities, without any irksome interference with personal liberty, simply by the provision of stree pillar-boxes, with the necessaries of first aid, including perhaps a couple of scaling-ladders, and, further, the arrangement of some opport tunities for householders to learn how to handle them. Put a street-pillar of this kind in a fire-station, reserve certain afternoons in the year on which this elementary instruction will be given, and the students afterwards shown the fire-station, or treated to a "turn out," and there will be quite a number availing themselves of the oocasion. No matter if curiosity, real interest, or wet days brings them there, the object in view is obtained.

When I speak of outside help I, of course, in the first place, mean organised outside help, and not simply such aid as is tendered by the casual passer or the neighbour. The link between self-help and outside help is the fire-call.

The efficiency of the fire-call depends not only on the instrument employed and its position, but also on its conspicuousness and the indications given to find its whereabouts. These indications are quite as important as the instruments themselves. The conspicuousness of the instrument alone does not suffice. Of the official notifications given in the Press, those of the position of the call points are among the most important. An indication at every street corner as to the direction to take to reach the point, or perhaps better, as I also know it, the conspicuous advertisement of the nearest call point over every post pillar-box, and inside every front door, may enable even the veriest stranger to call assistance, and minimise the chances of seconds being lost in search of the instrument. I will not now refer to the instrument itself. It is immaterial for the moment if the helpers are called by a bell outside a fire-station, by a messenger from some special messenger service, if the call come through a telephone, or an electric automat. Any instrument will do that insures the call being transmitted with a maximum speed and certainty, and in full accord with the customs of the country.

As to the organised outside help, it may not simply be limited to the attendance of the fire brigade. Special arrangements may be made for the attendance of the local police force, a public or private salvage corps, an ambulance, or in cases a military guard. Then I know of instances where arrangements are made for the attendance of the water and gas companies' servants, even officials from the public works office, insurance surveyors, and the Press. I know places where the salvage corps arrives on the scene almost simultaneously with the fire brigade. I know others where the police generally are on the spot in good force five minutes after the first engines. I know two cities where the ambulance waggon and the steamers arrive together. Another where the military authorities always send a fire piquet which is turned out in ten minutes.

If all these auxiliaries come together no matter how high the rank of the individual commanders, the senior officer of the fire brigade, even should he only hold noncommissioned officer's rank, must have the reins, and his authority must be fully recognised. There are unfortunately not many places where this is the case, but I would lay stress on it that the efficiency of the outside help depends in the first instance on the clear definition of duties and powers of all concerned, the legal foundation in fact, then on the organisation, the theoretically as well as practically correct executive, and, last, but by no means least, the prestige, the social standing, the education of commanders and their ability to handle men easily. For the rank and file of the fire brigade, clear-headedness, pluck, smartness, and agility, will be as invaluable as it is dangerous to have reckless dare-devilry in the force, showy acrobatism, or the insane ambition for distinction.

Under the heading "fire research" I include all theoretical and experimental investigation as to materials and construction combined with the chronicling of practical experience in fires, then the careful investigation and chronicling of the causes of fires, assisted where necessary by a power of fire inquest for interesting, suspicious, or fatal cases. I also include experimental investigation as to natural and accidental causes as distinct from criminal causes. Research for criminal cases may not only be assisted by a fire inquest as we understand it, but also by immediate formal inquiries held on the spot, by the senior fire brigade and police officers present, or by immediate Government investigations held on the same lines as inquiries into explosions. As to the general research work, I would mention that there are several cities where, of late years, a number of experts have been regularly employed superintending a series of experiments on the resistance of iron, steel, wood, and stone. Some towns have special commissions of experts who visit all big fires within a day's travelling, take photographs and sketches, and issue reports as to how the materials were effected. Then there are the usual statistics as to the outbreaks, their recurrence and causes, and in some places such tables are supplemented by reports on experiments on oil lamps, their burners and wicks, electric wiring, and the like.

I said fire protection to my mind consisted of fire prevention, fire combating, and fire research, and I have tried to explain to the best of my ability what these headings cover. Before entering into detail, I should now wish to touch on the financial aspects of such protection, and mainly its relation to the public purse.

Fire Protection and Fire Losses.

We all know that property destroyed by fire is practically an absolute loss. This loss may only actually affect the owner, or it may be distributed among a number of people who are taxed for it in form of a contribution to their national or local fire fund, a share in some mutual insurance ring, or in the more usual insurance companies' premium. In the first two cases there are also some expenses to subscribe to in connection with the management of the fund or ring. In the latter case not only the expenses of management have to be covered, but also the costs incurred in running the insurance enterprise as such, and then a further amount for division amongst those who share the risk of the venture, in other words, the insurance company's shareholders.

We must here distinctly discern what is a loss and what is an expense. The sinking fund of the large property owner should cover a loss with a minimum extra expense; insurance in an extravagantly managed company paying large dividends will cover a loss but with an unnecessarily large extra expense. In every case the loss remains, and as property may always be considered part of a commonwealth, the community, province, or nation, as the case may be, suffers. It is always in the interest of a nation to minimise its natural losses, no matter whether they fall on one individual's shoulders or on many, if such losses are good for certain trades or not.

With a suitable system of fire protection it is possible to bring these losses to a minimum, but this minimum would probably only be reached by an extra expense, which would fall heavier on the insurers' pockets in the form of municipal rates than the higher premium for the greater risk. A *practical* minimum is all that can be attempted, and that *practical* minimum varies according to circumstances. Most property owners would, I believe, grumble if a greater immunity from fire were to cost them much more than the danger. They would prefer a greater loss to an extra annual expenditure.

Practical protection must mean smaller annual insurance dues, and the actual extra cost of this protection should be something

less than the saving off these dues. Then the nation not only has a smaller dead loss, but the owner also has a smaller annual expenditure for his combined contribution towards the losses, the management of his insurance, and the protective measures. Where there is mutual insurance or municipal insurance in its best sense, the losses by fire and the costs of the protection are often booked in one account, and the better protection up to a certain point should mean a smaller individual annual share. Where there is company insurance the municipal rates increase to cover the cost of extra protection, but the insurance premiums are expected to proportionately decrease. Competition and public opinion generally force this decrease of the insurance rates as soon as there is a greater immunity from fire, and where they do not, the appearance of that wonderful phantom called "municipal insurance" generally brings about the desired reduction. Where the insurance companies are well managed, and the shareholders are satisfied with reasonable dividends, protection can be said to find favour with all concerned, but if the protection is arranged for and the companies do not do their duty the result for the property owner is by no means a pleasant one. I unfortunately know several cases where property was greatly improved from the fireman's point of view and the ratepayers supplied regular surveyors and even a fire-watch, and yet the insurance company interested would not reduce its charge. Of course such tactics do not encourage good protection.

I may as well at once here touch on the questions of insurance companies subscribing towards the maintenance of a fire brigade. The argument municipalities use is to the effect that the insurance companies derive all the profit from a good fire service and should contribute towards its cost. Now, as just said, where properly managed companies have the business, a better fire service means a smaller premium to the ratepayer. If the ratepayer has to pay for extra protection in form of an increased municipal rate or in form of an increased premium, raised to meet the contribution levied, surely it is simply juggling with figures. Of course I full well know that the contribution in the latter form helps to popularise the municipal budget, but surely this is not of any real account. Now this is all quite independent of any argument in favour of fire protection being considered in the same light as police or sanitary protection, which are everywhere held to be ratepayers' affairs in the fullest sense of the expression. We do not hear of municipalities in want of a popular budget asking burglary and life insurance companies respectively to contribute to the expenses of their police force or sanitary department.

To refer to the advantages and disadvantages of municipal insurance in connection with this study would be out of place, and I scarcely hold the question to have any considerable bearing on the subject. At the most to my mind such municipal insurance could only further the actual protection by the opportunity it would give the authorities to fully realise the extent of the losses and the effect of their efforts. Any saving accruing for the ratepayers owing to shareholders' dividends and other extra costs not having to be covered in the insurance premiums should not affect actual protection. Of course the municipal insurance premiums may be so figured as to leave the authorities a revenue which is devoted to protective measures. This again is, however, generally only done to reduce municipal rates and juggle with figures. The protection actually required remains the same, and the ratepayer will have to pay for it no matter in what form.

I am no friend of municipal insurance if planned with the idea of obtaining a revenue from it, and I do not even hold a general fire insurance business to lend itself to official management. I however know a number of cities where the authorities limited themselves to taking house risks only, and most satisfactory results were thus obtained. In these cases, the chief ambition was simply to insure a maximum distribution of losses, a rapid re-erection of buildings gutted, and an economising of insurance expenses. Mortgage transactions on house property were facilitated and a reduction of the criminal cases obtained.

The Cost of Fire Protection.

As to the actual extra cost of a practical system of fire protection above that of the more usual merely combative establishment, I can only say that where changes for the better were made, it was really astounding how cheaply the greater immunity from fire was obtained. In the first place, I would point out that the special fire clauses embodied in a building act would of course be attended to by the same executive authorities as would in any case superintend the general structural matters, and that the additional work would at the most require some increased clerical aid.

If the execution of the fire survey regulations were delegated to the same authority, there would again simply be some extra clerical aid to pay for, and the salaries of perhaps a few extra surveyors. To make the inspections thoroughly efficient, it may be found advisable in instances to form parties of three for the rounds. The second man would, in this case, be a fire brigade officer, and the third probably a master chimney sweep, who would have to receive a special retaining fee.

The cost of the public training I referred to would be minimal, as the elementary part would simply be included in the schoolmaster's work, and the Press matters could be easily managed in the fire brigade office. Payments would only have to be made for advertisements, such as the official warnings, lists for fire-call points, &c., and perhaps for the publication of semi-official hints. Self-help, as far as inspection and drills for amateurs spoken of are concerned, would be in the hands of the fire brigade. There would, however, be an extra expense for the purchase and maintenance of the street appliances I referred to.

The most expensive items in the system of fire protection undoubtedly come under the headings—fire call and fire brigade. As to the former, however, I would mention that there are quite a number of cities where the cost is modified by having the whole of the electrical service for police, ambulance, and fire brigade, and even public clocks, managed by a separate municipal department. The same wires will call up each of these services, and as the same staff attend to their maintenance, the fire protection of a city need only be booked with perhaps a third of the outlay it would occasion if managed independently. The combined system has also the great advantage of facilitating the mutual working of the different services in case of an emergency. The call-point indicators which I have referred to, of course, also cost money, but here again, if the three services work together, the expenses on the count of fire protection can be lessened. Speaking of money rewards given in some cities to the individuals who first call the fire-engines, I would point out that such gratuities can become a heavy item, and I have some doubts if they in reality do much good.

As to the outlay on fire brigade establishment I would here only say that I am a friend of systems which allow for a strong active force supported by efficient reserves. The latter should be as inexpensive as possible, but by all means at least a part paid, and disciplined body which could be easily called in for emergencies. Fire brigade budgets cannot allow for an active force being ready for such curious coincidencies as an unusual number of large fires starting simultaneously, but they must allow for an ample strength always being forthcoming for the ordinary emergencies, and this with all due consideration of the men's rest and possible sickness. An undermanned fire brigade is an anomaly which is generally fatal not only for the property owner, but also for the whole efficiency and *esprit* of the force. The budget must also allow for an attractive pay, for the profession is one which requires men who have a maximum of the sterling qualities we look for among the pick of a nation. It must also not be forgotten that the fire service is one of the few where a system of pensions is the only fair way of recognising the risks of limb and health, and at the same time influencing that stability of a force in which the practical experience of long service is so essential. The budget must also not forget that an ample reserve of appliances is a necessity.

Whether the force should be so strong as to permit of its having a separate section for salvage corps purposes depends on circumstances. I at all events hold that if a Salvage Corps is required, it should be part and parcel of the municipal brigade organised on the same lines with a reserve, and this no matter again if the insurance of the locality be managed by the authorities or by the companies. If the corps is necessary, it matters again little if it be paid for out of premiums or rates. To my mind there would, however, not be very many towns where a special salvage section would find sufficient work, taking it for granted that general protective measures are good, and that the tactics of the firemen are such as will give no occasion to fear an unnecessary water damage. Of further expenses which have to be considered there are items for fire research and fire inquest. If managed economically, due confidence being placed in the opinions of the fire officers and surveyors, there is no reason why the outlay should be great. The statistical work would only require some clerical aid. Where special coroners are retained for criminal cases some extra money will of course be required, but even here the costs need not be excessive, as there are many retired fire brigade officers and fire surveyors who are most snited for the work,

and would well be satisfied with a small emolument.

The last items I wish to enumerate are those for the water supply. There are but few places where special fire high pressure mains are laid on in the interests of fire protection. As a rule the costs which are debited to the heading "fire protection" have simply to cover the maintenance of hydrants and tablets, or at the most the cost of the water actually used for fire extinguishing purposes. Sometimes the cost of hydrants is shared with the scavenging department or the Commission of Sewers, who also have the use of them. Where the provision of water and hydrants falls to a private water company, the property owners will, of course, be paying their share for them indirectly in the form of water rates.

Now you will have noticed that all the expenses referred to are such as to my mind fall on the public purse, and that I have not taken into account the actual cost of the better construction or arrangements which the Building Act and fire survey regulations would require. The property owner would have to cover this expense individually, but I shall not call it a special or extra outlay, as I consider stability with due attention to sanitation and fire protection should be the essence of modern building construction. Surely inferior construction not only shortens the life of a building, but it is also in every way detrimental to the interests of a *boná-fide* investor. Safe construction enhances the value of a property, and the protective measures need not occasion much additional expense. Why not consider fire protection just as much a primary necessity for building as the block signal system is for railway construction? Is there much difference in abetting a man's death by fire and his death in a railway accident? Why consider it more legitimate to spoil your neighbour's property by fire than to steal it? Bad construction means a risk to one's neighbour's life and property as well as to one's own. It may not only cause a direct loss, but also spoil the man's business for years, and throw those out of employment who are dependent upon him. Why permit injuries of this kind?

Now, this is the first time I have in any way distinguished between the safety of life and the safety of property. The protection of property to which I may have seemed to be specially referring this evening, must in any case include measures for the protection of life, as no fire can originate without there being some personal danger. It is practically immaterial if this danger affects the inmates or the firemen. The protective measures will stand good for both. Means for life-saving must be forthcoming as soon as possible after an outbreak has been signalled, as the helpers themselves may want them quite as much as those in or near the building attacked. It should also be remembered that both a good staircase and a ladder are often quite as useful for the manœuvring of the firemen as for life saving purposes, and that they are practically quite as essential for the saving of property as for saving life. I do not hold that any distinction need be made between the two risks when speaking of fire protection in general, but as the safety of a single human life is classed higher than that of the most valuable property, it may be well to give life-saving the first place when alluding to the two separately.

Up to the present you will have noticed I have practically only referred to the prevention of fires originating from natural causes, negligence, or accident. Criminal fire raising may seem not to have had sufficient attention. Well, to my mind there is little or no criminal work where a perfect system of fire protection has been introduced. What with good construction and a fire survey, the quick arrival of the firemen, and careful inquests, the risks of detection are far too great.

Fire Prevention.

Under fire prevention I first referred to the special requirements of the Building Act. The clauses can greatly influence the safety of life by requiring practical exits and sufficient staircase accommodation. I cannot here specially refer to the risks in theatres and assembly halls, which to my mind, require separate legislation; I simply speak of factories, offices, business premises, hotels and tenement houses. In no case should any inmate of a building be further away from a staircase than sixty feet, and preferably there should be two staircases at his disposal in the event of one being blocked. Generally attention is only given to the construction of staircases; I would point out that there ventilation is equally important. Smoke is even of a greater danger than fire, and can hamper the helpers terribly. The possibility of opening a few windows has saved many a life.

As far as the protection of property is concerned, the prevention of outbreaks can be influenced by the careful construction of flues, hearths, stoves, and, in certain classes of

buildings, by the construction of floors and ceilings, the arrangement of sky-lights, shutters, and lightning conductors.

Then comes the prevention of the fire spreading, first, by the division of risks, secondly, by the materials used in construction. I believe that one nation always speaks of "slow combustion buildings," an excellent term, as the expression "fire proof" is a misnomer, and "fire proof" buildings are impossible for practical purposes. When I speak of the division of risks the legislator's first ambition must be to prevent fire in one house spreading to another and, a stranger's property, so to say, being endangered. This is quite possible, given good party walls carried well over the roof to a height regulated by the nature of the risk, the arrangement of shutters to windows where necessary, or the use of fire-resisting glass. Either a thoroughly good roof, or even better yet, a fire-resisting attic floor can do much. If the locality has a proper fire brigade and the force is decently handled, "spreads" from one house to another can be absolutely barred. In the most dangerous class of warehouse property, I have seen party walls which do not only project above the roof, but in front of the facades of the building. This is perfection, though generally too expensive.

The division of a building or a large "risk" into a number of minor ones is only possible to a certain extent. I do not hold with spending enormous sums in order to make each of the minor "risks" impregnable. My ambition is simply to try to retard the spread for a certain limited time after the flames have really taken hold of the contents. In those minutes most fires will have been discovered, and a sufficient number of firemen can be on the spot to localise the outbreak, and prevent the conflagration being a big one. Take a drawing-room in an ordinary well-built house. If the joists are strong and the boards grooved, and if some light pugging be used and the plastering properly done, if the doors are made well-fitting and fairly strong, a very considerable amount of furniture and fittings can be well alight for half an hour before there is a spread. In a warehouse or factory "risk" the same holds good. With well-built wooden floors, thickly pugged, and the ceilings perhaps run on wire netting instead of on lathes, with ordinary double ledged doors safely hung, at the most perhaps lined with sheet iron on asbestos cloth, a very stiff blaze can be imprisoned for an hour. The general mistake of expensive iron and concrete construction is its aptitude to allow some breach being easily made through which the fire spreads. The iron door bends and so does girder work. Then, again, directly a fire has got a hold these composite floors are much too dangerous for firemen to work on or under. They cannot get near enough to the actual seat of the fire. Further, if a strong stream of water touches the hot iron there is often an extra danger which can only be rivalled by the effect of a falling weight which also so easily brings about a general collapse. Then after the fire has been extinguished the ironwork will be so damaged that it will require entire renewal, and the brickwork will probably be so strained and bulged that the re-erection will have to commence from the footing. A simpler construction is in most cases the most satisfactory, and I should generally advise it as an architect. The few iron and concrete floors, for instance, which will stand some strain are to my mind too expensive to allow their introduction for fire protection alone, and when I speak of their cost, it must be remembered that it is not only the expense of the floors which have to be considered, but that also of the supports and the surrounding walls.

When speaking of the division of minor "risks," the dangerous lift wells, skylights, and shaft openings should not be forgotten; the latter should be as small as possible, well armed with shutters, the skylights should again have fire-resisting glass, and the lift not only vertical doors, but also horizontal flaps, which would cut up the well into sections.

Division of "risks," commonsense construction, and proper staircase accommodation are really all that fire protection requires, and where the special Building Act clauses have been kept within the lines I have indicated there has been little friction and discontent. It is only when, as I have known it in a city that, for instance, a tenement house is always required to have a large passage-way, through which a fire-engine could gallop into a courtyard, that the property owner very rightfully considers himself harassed by the protective measures.

As to the fire survey regulations, they should mainly prevent the actual outbreak of fire. In certain classes of risks fire survey can also increase the personal safety of the inmates, and the possibility of a fire spreading may be lessened. The provision of fire-escapes or ladders, and a regular inspection of their efficiency, will do so much, and the

examining of a rusty door-catch may save a building. The actual preventive work of the surveyor will, however, mostly consist in the warning of property owners against temporary stoves standing on ordinary floor boards, sooty chimneys, badly hung lamps, dangerous burners and gas brackets fixed in risky positions. Self-help will be greatly facilitated by the judicious arrangement of fire extinguishing gear, and a like inspection of its efficiency. Hydrants and cocks must not rust, nor must the hose get so stiff that water cannot pass through it. Hand pumps and pails must always stand ready filled. In distributing such apparatus I would point out that one of the greatest errors generally made is to forget that the amateur fireman likes to have an easy retreat if his efforts are unsuccessful. Otherwise he may not care to use the gear at all.

I would here like to refer to chimney cleaning. In some countries, in case of a chimney fire, the owner of the property is fined for not attending to his chimneys. In others the chimney-sweeps are also made responsible if the owner can prove that he has had his chimneys regularly cleaned. Another way of treating the matter is to have official sweeps, who have the same rights as the dustmen of certain places, and can enter buildings and clean the chimneys at certain intervals after due notice. The chimney sweeps are then alone held responsible. In the case I have in my mind, the municipal chimney sweep department always had several men ready for attendance with the fire survey officers, and there were also some at the fire-stations ready to turn out with the firemen to a chimney fire when required.

It is, unfortunately, quite impossible to-night to touch regulations governing the "special risks" I referred to. I will only here say that as far as the safety of the public in theatres and public assembly halls is concerned, attention, to my mind, should be chiefly given to the exits. Spread of fire and even its outbreak, are secondary considerations. A panic caused by a suspicion of fire can be quite as fatal as a conflagration actually started. As to the petroleum storage in shops, I would give most attention to preventing any direct communication between the shop or cellar and the main staircase or the living-rooms. As to the lamp question, why not prohibit the sale of dangerous lamps and burners in the same way as the sale of dangerous food?

Fire Combating.

As to self-help, I would only add that complications must always be avoided, and that the amateur fireman, above all, must be drilled on the simplest lines. I am a great friend of competition where volunteer work is concerned, and have always found annual prizes to be a good investment. One thing, however, must be instilled into the amateur mind, and that is not to waste water, a sure sign of a lack of training. Of course, the drills must be on the same lines as those of the local brigade, and on no account should other gear be used for self-help than is generally customary in that force. When volunteers and regulars work together the latter should always remember that the paid force are experts, but the regulars must also never have that ill-bred contempt for volunteer work so often noticeable among the vulgar or mercenary. Volunteers are volunteers who are probably experts in some other vocation outside fire fighting, and have not had the opportunities of a professional fire fighter.

There is one point still regarding self-help which I may touch on. There are authorities who dispute the advantages of both organised and independent self-help, and who prefer the immediate call of outside help only. These authorities remember the futile help of the amateur, and perhaps the door he opened which fanned the flames before there was a sufficient supply of water ready to counteract the effect. Where there is more than one helper at hand, it is always necessary to see that the regular fire brigade is called, and where there is one man only, he should never attempt self-help if the fire is well alight, but call the engines. If the fire, however, is small, and engines cannot be had within a few minutes, even if alone he should always try self-help. Of course so much depends on the circumstances, and also on the temperament of the first comer. Excepting one or two countries, where the natives are all too excitable, I hold that self-help, both organised and unorganised, should be encouraged.

I must now give some minutes to that invaluable link, the fire-call. There are several methods of transmitting the message. The simplest is of course to run direct to the nearest fire-station, but this is only possible where the distance is small. In one or two cities, however, the number of fire-stations is so great that they are very close to one another, and hence what I will term "direct" calls are generally recorded.

Then comes the system of special messengers. The fire is reported at some public office, police-station, or guard-room, where there are always runners ready to start off to the nearest fire-station. The special runner is, of course, practically here simply a make-shift for the more modern telegraph or telephone line, and the only city in which I know this system to be employed is one where the unsettled political atmosphere has compelled the authorities to prohibit the construction of any telegraph line other than those for the use of the general postal service. Similar messenger services have, however, also been introduced in connection with the telegraphic signalling system. I refer to the private enterprises known as general messenger or call-boy services, which are organised for business purposes, and have the advantage of the fire-call with the police-call thrown in. In the same way as a cab can be signalled, a call may come for a fire-engine, and the ever ready runner makes off to the fire-station, instead of to the cab rank. As a rule, these messenger offices are near the fire-station. The combination is really rather a curious one, as it embraces the most advanced notions of giving every "risk" its own fire-call, and the somewhat out of date one of the special runner. I have often wondered why these messenger offices have no special wires to the fire-stations.

Another system for facilitating the fire-call relies entirely on the public telephone system, the terms of subscription to which may compel holders to forward fire messages, if required to do so. This system allows for such development as the payment of retaining fees to porters in public and other buildings which have a night service, on condition that the fire-call be promply despatched. The telephones are, perhaps, even provided free, if they are not forthcoming; but it should be remembered that the service always goes through a General Telephone Exchange.

Then there is the special telephone line system, where special wires are laid on to buildings which are practically open all the year round, direct to their nearest fire-stations, and some payment is again made for prompt attention. Sometimes telegraphs take the place of telephones, but this requires the porter or attendant to be specially trained to the work. To simplify matters the buildings are sometimes fitted with automatic fire-calls, instead of telephones; but the principle of the system remains the same. In districts where there are few public offices the list of buildings at which messages can be handed in have been frequently augmented by a set of bakeries or chemists shops, where night service is not unusual.

What I will term semi-public street-alarms come next. Automatic fire-calls are put up in the street, but their handles are under lock and key, and the keys are only distributed among policemen, watchmen, or householders, and the messages can, hence, only be given by persons known to the authorities.

The public automatic street-call is the last on my list. It is the simplest system next to what I term the direct message. Of course, I know that private automatic fire-calls or telephones can be laid on from dangerous risks, and there has even been an instance where an attempt was made to give every householder a private fire-call. This system is, however, unfortunately too extreme for the municipal purse. If in connection with some other paying enterprise, as in the case of the messenger services referred to, it would be a different matter, though it should also not be forgotten that too great a number of call points means a probable repetition of signals to the same fire. As every call should be answered, two separate fires can quite easily occur about the same time in the same neighbourhood, there is a risk of too many sections of the fire brigade being unnecessarily on the road to one fire.

As to the position of call points, they should not only be conspicuous, but they must also be in most frequented positions. May be in some towns a point in front of a church would be the best; in others, it may be more advisable to have them in front of a public house or cigar shop. It should always be remembered that every facility should be given to enable as many people as possible knowing the whereabouts of the call points without any distinct effort on their part. Red paint may make a call pillar conspicuous by day, and a coloured lamp is necessary by night.

As to the indication I spoke of, the plate on every letter-box indicating the locality of the nearest call point is perhaps one of the best. The letter-box is one of the most used instruments of a modern city and the plate is hence read by many. In an Oriental town the public fountain would however, of course, take the place of the letter-box. Plates put up inside every front door are somewhat extreme measures. In one city I saw small red darts painted on the glass of every street lamp indicating the direction to be taken to come

across a street alarm. This sign, however, has the disadvantage of requiring a previous knowledge of its meaning. It is generally useless to a stranger in the town.

As to rewards paid to messengers, I know them to vary from one shilling to half a sovereign. In some places every call is rewarded, that is to say, also those to chimney fires, and this often results in an abuse. I have actually known rogues to light bogus fires on the top of a chimney, and then run to call the engines. If a reward be given, a limitation should be made. In one town I know no relation or *employé* of the owner receives a reward. In other cities no rewards are, for instance, given for calls to a fire in a dust-bin or a chimney. As to the amounts paid, of course it depends on the value of money in the respective countries.

Here I must add a few words as to false alarms. No true fireman would be annoyed at a false alarm given by mistake. The possibility of a fire, or the suspicion of one, are *boná-fide* reasons for a call which should not be discouraged. Malicious alarms should, however, be treated with utmost rigour, as the absence of firemen from their stations always means an extra risk to life and property. More, distant helpers may arrive too late. Combined lynch law with imprisonment has been adopted with good effect in one city I know. The rascal when caught was put over the pole of the engine and thrashed with a broad fireman's belt, and after that he was handed to the police. Hard labour has had much effect, especially also inflicted on persons of position. Only a short time back the son of a well-known mayor had a month's hard labour for a malicious call, and there was at once an abatement of the evil. Fines are a ridiculous punishment for this kind of offence. They almost encourage the moneyed imbecile or ruffian. Where the punishment for malicious alarm is severe there need be no recourse to the semi-public automat I spoke of, excepting perhaps in the veriest slums of a city.

The fire-call should, if possible, also be so constructed as to facilitate intercommunication between the scene of a fire and the head-quarters of the fire brigade. Where the runner is employed or the telephone is used no special arrangements are required, but where the telegraph or automatic call point have been introduced, the apparatus must be adapted for this contingency. At some automatic fire-call points a few signals can be given, at others a telegraph or a telephone transmitter can be applied. Much valuable time may be saved in this way when more assistance is required. On the other hand I again know towns that make a point to keep up a line of intercommunication for every fire, so that in case of an emergency part of the men in attendance there could be called away to help elsewhere. In some places the head-quarters of a fire brigade are in communication with some watchmen on a neighbouring tower or steeple, who can signal any increase in a large fire by the change of light the blaze shows.

The organisation of fire brigades is most varied. As to the hours of duty there are brigades where officers and men are practically constantly ready to attend a fire, others where they are ready on alternate days, two days out of every three, or three days out of every four, and the off day is entirely their own or at the most only partially used by the authorities for some light work. The men off duty are only expected to attend a fire if there is a great emergency. The brigade is strong enough without them for ordinary eventualities. Both systems can be worked with or without part paid or volunteer reserve. These would be only called out for great calamities. They could be organised as practically independent reserve force, or the reserve men might be attached to sections of the regulars and mixed with them when the occasion arises, in the same way as our naval reserve men mostly are. The reserves can either consist of retired firemen who have a few regular drills, or amateurs who have to go through a special course of training with some regular drills at intervals and preferably a short spell of service every year with the regulars. I prefer the reserves to be a distinct body. As regards the hours of duty for the regulars, 48 on to every 24 off has given the most satisfactory results.

As to the division of the active force it may be on a system of a number of small parties of twos and threes backed by one or more strong bodies. Another system allows for a division into sections of equal strength (so-called "units"), ranging from parties of say from five men with a non-commissioned officer to thirty non-commissioned officers and men with an officer. The force can of course also simply be divided up into parties or sections of different strength not governed by a system of military units; the sections or "units" can either work independently, simply governed by one central authority, or they can be grouped into minor or major bodies (so-called districts or com-

panies), which are, as a whole, responsible to head-quarters.

As to the officers they may be all taken from the ranks, or they may be officers and gentlemen in the military sense, who have only temporarily done work with the rank and file when in training. There could also be a combination of these two systems. Only the captain and deputy-captain might be officers in the military sense, the sections or divisions being officered by non-coms. Some cities have an officer to every thirty non-coms. and men, whilst others put a division of as many as two hundred under a fireman who has risen from the ranks. Where protection is treated as a science, and where those in charge of a brigade have really to act as advisers to their employers, officers in the military sense have been found essential. They have also been found advantageous where their scope is limited to fire extinguishing. The prestige of the fire service has been raised everywhere where the officers, besides being fire experts, are educated men of social standing. There are cities where the officers of the fire brigade are in every way recognised as equal to army or navy men, their social position is the same, and their mess fulfils the same functions as a regimental mess. The fire brigade officer is recognised at Court, and there is no ceremonial without him. On the other hand, there are also cities with brigades several hundred strong where the captain, who may of course be a very fine fellow, would unfortunately seem quite out of place in any recognised club room. His social standing would only be par with that of a colour-sergeant. As to the primary training of a fire brigade officer, I may as well say that the best men have generally had some experience in another profession such as the army, the navy, or the architectural and engineering professions previous to their entering the fire service. Some brigades recruit from army officers only, and preferably from the royal engineers or artillery regiments, others recruit from among architects and engineers, subject to their having at least had some military experience in the reserve forces or the volunteers. Some cities always only take engineers or architects, and make a point of it that they should have no previous military experience. I hold that some previous experience in the handling of men is essential. Royal engineers and architects of some military experience have, to my mind, nearly always made the best officers.

As to the men, there are cities where only trained soldiers are taken as firemen; others where the engines are manned by sailors. In some towns the building trades supply the recruits; in others, all trades are either discriminately or indiscriminately represented. I have generally found a combination from the army or navy and the building trades most satisfactory. The knowledge of building construction in the ranks does the force good stead, and has already saved both lives and property. Where a brigade can boast of a few men of each important trade much money has been saved the ratepayers, by the men doing their own repairs and refitting, but the number of men from sedative trades should not be excessive. Where there are only men of one trade or calling, I generally found too great a tendency to onesidedness, and a wonderful amount of prejudice.

I suppose I need really not specially mention that physical strength and a perfect constitution are requisite for both officers and men. As to the height of the men, I can only say that I have found small, wiry men to come in very handy. First-class eyes, ears, and nose are necessary, also a good memory. There is one point I must here not omit, and that is, that many brigades only take single men; non-coms, and officers only are allowed to marry. As to age, there are many brigades where 22 and 40 are the limits for the privates, 50 for the non-coms., and 60 for the officers.

As to the equipment, there are brigades which have all their sections or units provided with practically the same gear; others where each unit has a double or treble set, one of which is used, according to circumstances. The section may have a manual engine, a steamer, and a ladder truck at its disposal, and may turn out with either. Then there are towns where the units are differently equipped, and we find steamer or manual sections called out, as the case may be. In a few extreme cases, where the sections are very strong, they may be equipped with a set of engines and trucks, and the unit, in every case, turns out complete with (say) a manual, a steamer, and a horsed escape. The contrast to this will be found in the small parties of twos or threes I referred to, whose turn out would only consist of a small horse trolly or an escape. Of course, there are all kinds of combinations. I have known sections to have one or more independent sub-sections. Though practically belonging to the "unit," the sub-sections would work independently in charge of a certain gear, say a hose car, a long ladder,

a fire suit, or a smoke helmet, according to circumstances. The sub-sections may also act as outposts—if I may call them so—as a station guard, or simply as specialist parties, which are only called out for particular work.

As for the housing of the units or sections, there are the simple street stations for the small parties referred to. In a few cases, I have known two small parties to be under the same roof. The large bodies that back them are generally quartered together in extensive barracks, from which any number of engines and men can be turned out according to the nature of the call. Then there are cities where every section has its own well-built station; others where one or two sections are housed together, according to circumstances, and perhaps as many as half a dozen located at head-quarters. If groups are formed, the head-quarters of the group or district perhaps has two sections, while each of the other stations only have one. The general head-quarters may be the central station of a district at the same time. The actual working of the district head-quarters would, however, then be kept separate from the working of the head-quarters staff. The latter would, perhaps, have some sections ready to send anywhere, besides the trucks—necessary for the officers—any general extra gear, &c., that might be required. It is usual to combine workshops, stores, hose drying towers, &c., with the head-quarters station, and, in some cases, also with the district centres.

As to the distribution of the stations, the formation of districts, &c., various systems have been adopted. The most satisfactory results have been obtained where a fully-equipped section (not simply a hose-car or escape party) can reach any building in the city within seven minutes from the time of the call reaching the station, the seven minutes including for both turn out and run. Where there are exceptionally large or dangerous risks this time has had to be shortened to five minutes, and the possibility of an attendance from a second station assured within eight minutes. In dividing up districts the most satisfactory results were obtained where every house could be reached from the district centre within fifteen minutes from the call. Head-quarters would naturally have a central position in the city. In one or two instances I have known the head-quarters offices to be located in a separate building, which in no way served as a fire-station, but simply as a centre through which all orders and business passed. I am no friend of this arrangement. The different stations must, of course, be in connection with each other. Excepting in the one city already referred to, the special runner or rider have practically disappeared. Telegraphy and telephony take their place. Some cities favour Morse telegraphy. It certainly had great advantages over the telephone till within a year or so, as messages could be easily transmitted to several stations with the same effort, but telephone distributors have now been successfully introduced. Errors are, I believe, less frequent by telegraph than through the telephone, and there is always a record of every message. The most modern forms of telephone communication are, however, more suitable for the fire service than the telegraph, though I should by no means advise the great expense of their introduction where there is a good system of the older link. Head-quarters should be in direct communication with every station, but every station should be able to communicate with its neighbour directly, as well as through the head-quarters office, and there should be a direct wire to its district station if it has one. There should be three routes of communication, so that two would be always ready for use in case of one breaking down. Either head-quarters of the district centres would be in touch with the various auxiliaries referred to, as well as the general telegraph office and the telephone exchange.

As to the attendance at fires some cities always only turn out one unit to answer the first call if they have no particulars, others always turn out two or three sections, and there are several cities that I know where the district centre would at least send an officer and a few men as well. In one brigade head-quarters is always either represented by the chief or second officer in the case of a call of this kind. The idea is that it is always better to have too strong a force quickly in attendance than too small a number of men, and that it is most important that the first arrivals should be well handled. Further, if two sections answer a call and one breaks down on the road, there is no chance of there being too great a delay in the arrival of organised help. It should, however, as I said, not be forgotten that further calls in the same district to other fires are not unusual, and that the absence of too many engines on account of a first call is dangerous. In some cases when a call reaches the firemen one or two of the nearest stations turn out, and if more help is required other sections will be called up

individually. In others the reinforcements are not called up separately, but the fires are divided into three classes, small, medium, and large, and on the message arriving of a more extensive conflagration, the sections already know beforehand if they must attend or not. First calls to certain classes of risks, say theatres or public offices, may always be considered to be for medium or large fires, and the same message will then simultaneously turn out the stronger body without any further detailed instructions having been necessary. In two towns I know the fire - call automats are so arranged that the messenger can call for the different classes of fire. This is, however, not to be recommended, as an excited messenger will probably consider the smallest fire to be a gigantic blaze, and will turn out too many engines.

It is quite impossible for me to here enter into a description of the appliances or working of brigades. Besides requiring some considerable time, I should have to describe a number of institutions individually, and that is not my intention now. I will only point out that where there is a high-pressure water supply some brigades simply attend with hose cars, life-saving gear, and ladders, or instead of the hose cars, take their manuals, which they never use. Others take and make a point of it to use the manuals, and have a barrel with them ready to supply the first gallons of water necessary. Time is thus not lost in connecting with the nearest hydrant or plug, and in case of a hydrant being out of order, there is always sufficient water at hand until the second hydrant has been found. Some cities always have an attendance of steamers, which are, however, only used in urgent cases. In other instances the steamer is at once used in the same way as the manual, and this quite independent of the pressure there is in the water service. Where there is no good water service, manuals or steamers of course have to be sent out, and are either used off the low-pressure service, or off the natural water ways or wells. Of course there are yet a large number of cities where the suburbs have no proper water service. The water barrel comes in very handy here for porterage.

As to life-saving and manœuvring gear, some brigades rely almost entirely on long ladders, scaling ladders, or telescopic escapes. In one city I know great confidence is placed in the jumping-sheet, in another chutes are much used, and there are a few where wonderful work is done with life-lines. Simply to indicate the diversity with which any one appliance can be treated, made, or handled, in the fire service, I would mention that there are quite ten different ways in which a jumping-sheet can be held. Then there is the material of the jumping-sheet to be considered, the size and the shape, if round, oblong, or square, then the means of holding it, the way to fold it, how and where to stow it, and at what distance from the endangered building the sheet is to be held. Last, but not least, come the words of command.

As to the working of brigades, I must limit myself to saying that there are, first of all, forces where all possible attention is given to the actual rapid turn out, whilst there are others where the speed at which engines are run to the fire is considered to be of primary importance. Other brigades, again, give equal attention to both. There are brigades which work entirely on military lines, each man having certain duties marked out for him beforehand for every possible occasion, and there are others where happy-go-lucky working is preferred. Of course there are combinations in the same way as regards command. I know one chief officer who always arrives at a fire with a staff of adjutants and orderlies and controls the working of his brigade from a position of vantage at a distance. Another chief of a strong brigade always delights to be in the thick of a fire, perhaps at the branch itself, or on some gallant life-saving exploit where he no doubt does good work as a fireman, but in no way fulfils the office of a commander. Officers must remember that they are officers and not rank and file, and this is generally very very difficult to those who have advanced from the lowest grade. Superintendents, however smart, must leave acts of bravery to their men, and chief officers, without going to extremes, must always be in a good position where they can superintend everything pertaining to the outbreak in question. Some brigades seem to make a point of it to work quietly, and shouting is absolutely barred. All commands are here given by shrill whistles. In some brigades all commands are given by word of mouth, and there is much bawling. In others commands besides being bawled are even repeated on horns, and the noise becomes ridiculous. As a rule, quiet working is a sign of efficiency.

Some brigades work as close as possible to the fire, others are satisfied with putting water on

or about the fire from a distance. Some attack the fire direct, others only try to protect what surrounds the seat of the flames. In several brigades the orders are to always try and attack by the natural routes of the front door and the staircases. In others, the men always have to attempt some more unnatural entrance, with the aid of ladders; through windows, for instance. Some brigades carefully extinguish a fire, some simply swamp it. I know cases where officers will go so far as to let a roof that is alight burn itself out, simply keeping the surrounding walls, or say attic floor, damp. This prevents unnecessary water damage. The roof will have to be renewed anyway; why, also, spoil a number of rooms below? Handled by judicious officers, several brigades have been able to boast of never having damaged property unnecessarily. They have, for instance, had the patience to suffocate a cellar fire, instead of putting the whole cellar under water. In certain classes of property the bucket, the hand-pump, and the mop have been far more effective in minimising actual destruction than hose, which can ruin more by water than the damage by fire would have. It is one of the easiest signs to judge the training and handling of a fire brigade by, to see what damage they do. Even an inconsiderate smashing of doors and windows, when there is absolutely no need for it, can be avoided, where every man in the force feels that his first duty is to prevent damage and loss, and his second to extinguish the fire.

Where the brigade includes a salvage division, it is generally stationed at head-quarters; where this division is split up into sections, there would also be a distribution among the district centres; the salvage men are simply part of the force, told off on special duty. Where there are private salvage corps, their stations are generally near the head-quarters or district centres of the brigade, from which they receive notice of the fire. In some cities the salvage corps work quite independently; in others, they work under the chief of the brigade directly they arrive at the fire.

I am afraid I cannot even touch on the working of other auxiliaries excepting to say that there were a number of cities where the advantage of firemen having plenty of room to work in is fully recognised, and the police are at once called out with the fire brigade and brought on to the scene in an incredibly short time. There are always vans ready horsed at the police head-quarters to take out a squad of men when the fire-call comes, and a certain number of mounted men are also kept ready for this purpose. The value of these measures should not be underrated, especially in cities prone to rowdyism or political demonstration. If the firemen are unpopular their work will be doubly difficult for them. By the bye, there is however one thing I cannot omit, and that is to point out the value of firemen being trained ambulance men, especially in localities where independent ambulance corps do not attend fires.

DISCUSSION.

Commissary-General Downer, C.B., said it had been suggested that he might give some information with regard to the work of the Metropolitan Fire Brigade, as he had the honour of being for some time chairman of the committee of the County Council which had the supervision of it. There was not time to go at length into the many points raised in this very exhaustive paper, and he could only refer to one or two. Allusion had been made to buildings being so constructed as to be as little liable to damage from fire as possible, and on that point the County Council insisted that theatres and public halls, for which their license was required, should comply with certain regulations, in order to guard against fire, and to protect life. The first object of any fire brigade should be the protection of life, and, the second, the protection of property. With regard to the storage of petroleum, again, people were only allowed to keep a certain quantity on their premises. Each year the chief officer made a report to the County Council, which contained a great deal of valuable information; and he might quote a portion of an article from the *Local Government Journal*, dealing with the last report. It appeared, from the extract quoted, that there were in the metropolis about 3,400 fires a year; that very serious fires—such as destroyed whole streets—were on the decline, owing to improvements in modern building, to the fact that the brigade was yearly gaining in efficiency, and to the further fact that the constant supply of water was rapidly spreading over the whole of London. It was true that there were about 100 lives lost in London, annually, by fire, but that was not a very high percentage out of 5,000,000, considering that fires were happening every day. In his opinion the brigade was undermanned, but that was a matter on which they had to be very careful, as it affected the ratepayers' pockets. Few people had any idea of the value of the property insured; at present it was estimated at about £828,000,000, and the insurance companies paid a contribution to the Council in aid of the brigade expenses of about £29,000. The Government also paid £10,000, and all the rest had to be defrayed out of the

rates. The question of volunteer assistance and reserves was a matter of organisation. Although willing men might at times be useful, the opinion of the chief officer of the brigade was that he would much rather have his own trained men to rely on than any amateur assistance. All the firemen were recruited from the Royal Navy, or the mercantile marine, and sailors were admirably fitted for the work, which required great coolness, steadiness, and pluck. He should not like to call on untrained men to do the work which he often saw done by firemen.

Major Dixon (National Fire Brigades' Union) said they were all much indebted to Mr. Sachs for this very careful paper, and he only regretted there was not more time to consider it. As an amateur commander of an amateur fire brigade he was bound to stick up for amateurs. For many years he had the honour of commanding the Sutton Fire Brigade, having numerous appliances, two fire stations, and a complete system of communication, in fact, they had practically adopted the system Mr. Sachs described. Besides numerous electric alarm posts, they had eight call-points at houses where there were persons always on the spot; every householder in the district had a card to hang up—giving not only the various call-points, but the names and addresses of every fireman in the district, and there was electric communication between the fire-station and every fireman. He had a telephone from his bedroom to the fire-station, so that he could be called at any moment, and within seven or eight minutes he could guarantee to have the strength of the brigade ready. In districts where there was no regular fire brigade, it was essential to have amateurs who were trained to the work, and he considered that the greatest credit was due to men who would spend the day at their ordinary work, and who would turn out to extinguish a fire without any pay, and take turns to sleep at the fire-station, two each night, as was the practice in his brigade.

Captain C. J. Fox (Fire Brigades' Association) said he also must say a good word for the volunteer system. For 18 years he worked as a volunteer with the Metropolitan Fire Brigade, and during that time he saw a good deal and a very serious abuse of the volunteer system. With regard to early training, if the School Boards were to pay some attention to this matter by training children how to leave a room rapidly, what to do in the event of a fire, and how to get down a rope, there would be much less loss of life. At the terrible fire recently at Hammersmith, where seven lives were lost, some at least would have been saved had the father only been taught to shut the door after him. He went upstairs, leaving his door open, and the people outside burst the shop door open, and there was a thorough draught through. A few nights afterwards a similar thing occurred in Whitechapel; one after another the various persons were called up, in each case the door being left open, and in ten minutes they were all dead. If the first door had been shut nothing of the sort would have occurred. With regard to the Building Acts, a great deal yet required to be done. Where buildings were passed which were supported on perhaps three iron columns, with three stories above, supported on iron girders, if a fire took place in the shop the columns were sure to bend, and down came the whole building. A fire brigade officer, whose first duty was to protect life, could not expose his men to the danger of standing near such walls. If large firms knew how much they could do for themselves and their neighbours at a small expense, by organising a brigade of their own. more of them would do so. Not long ago there was a great fire in the Old Bailey, when a large block of reputed fireproof buildings became a heap of bricks in a few hours. Cassell and Co.'s fire brigade saved an immense block of buildings adjoining, and the whole of the printing works, though a very large portion was only covered with glass. That showed what an individual fire brigade could do when well organised. The way the Factory Act was administered was abominable. He could show within a mile of that place a factory which had been built within the last year or so where the iron staircase put up in accordance with the Act to admit the escape of operatives from the upper floors passed two windows, out of which flames would be issuing if the place were on fire. These things happened because the architects or surveyors who passed them had not sufficient technical knowledge; trained firemen should be engaged in such cases. He had great hopes of what the Parish Councils might bring about with regard to small fire brigades, though generally the first thing the ratepayer did was to grumble at the rate for the fire brigade, though it was really the best form of insurance. Paraffin lamps were a constant source of danger. Almost every evening paper contained an account of some horrible accident they had caused, and yet they were displayed in every shop window at prices from 7½d. to 2s. 6d. People ought no more to be allowed to sell paraffin lamps with glass reservoirs than to go about the streets with loaded firearms.

The Chairman, having proposed a vote of thanks to Mr. Sachs, which was carried unanimously,

Mr. Sachs, in reply, said he had purposely avoided mentioning the names of any town or city, and therefore could not refer to the London Fire Brigade. He thought there was some misunderstanding with regard to what he said about volunteer assistance. He should like to see reserves of properly trained and responsible volunteers, or better, partly paid amateurs, because there were a great many things which could be done very well by amateurs, and in cases of emergency—as when

several large fires occurred at once—such help would be invaluable. In small towns, again, volunteer fire brigades could do wonders, but his paper referred rather to large cities; there, when the rates would not go far enough to provide a brigade which was equal to all emergencies, organised, partly-paid, or volunteer help would be very valuable. With regard to the surveying of buildings, a commission consisting of an architect, a fire officer, and a chimney sweep, had been found most satisfactory abroad.

Mr. JAMES SHEPPARD writes :—The first line of defence against the commencement and extension of fire in buildings should consist in planning and constructing them in such a manner as will give reasonable security, having regard to the purposes for which they may be used and the probable effect of fire upon the structure both from within and without. Improved bye-laws regulating buildings, with the object of securing the foregoing and other advantages, have been recently adopted in several cities, and the London Building Act, which comes into operation on January 1st, 1895, contains improvements on earlier rules, having a similar object in view. Many serious defects, however, are perpetuated in this Act which might have been corrected, probably without raising the slightest opposition. The following list gives some of these defects, showing that the new Act deliberately sanctions, if it does not actually encourage, practices which are sure, sooner or later, to cause fires in buildings where these legalised evil practices are adopted :—(1) Section 64, Sub-section 4, of the new Act provides that flues for all close fires used for trade purposes and for cooking ranges in hotels, taverns, and eating-houses, shall be enclosed with brickwork $8\frac{1}{2}$ inches thick, from such fires or ranges to the level of the ceiling of the room next above that in which these close fires or ranges may be situated. The most dangerous points in flues from close fires and ranges are shown by experience to be where those flues pass between ceilings and floors, at which short bends are often found causing considerable accumulation of heat in close proximity to wooden joists and other timbers—the distance these points may be from the fire making but slight difference. Any increased thickness in the brickwork round such flues should not therefore stop at the ceiling level, but be continued at least to the level of the surface of the floor over the ceiling. (2) Sub-sections 15, 16, and 17 of Section 64 regulate the arrangement of slabs and hearths for chimney openings, and allow these to be of stone, slate, or other incombustible material. Slate is one of the most treacherous materials under the action of heat and fire used in building construction, and is altogether unsuitable for hearths. Any material used for hearths should be a non-conductor of heat, as well as incombustible. An iron hearth, six inches thick, as allowed by the Act, would be likely to lead to the ignition of any combustible material under it. The need of a material of a non-conducting nature for hearths is recognised in Section 66, why not therefore in Section 64? (3) Sub-section 22 of Section 64 allows iron holdfasts, or other iron fastenings, to be fixed within two inches of the inside of a flue. The heat-conducting nature of iron is here again overlooked. In fixing such holdfasts or other fastenings it would not be possible to avoid displacing the inner lining of the flue, one end of the iron would therefore be subject to the full heat of the flue, which heat would be conducted to the opposite end of the iron, and if this end is in contact with timber, as it probably would be, fire sooner or later must result. Several fires have been definitely traced to this cause, and in one fire so caused a woman was burnt to death past all recognition. (4) Section 66 allows stoves heated by gas to be set on wooden floors without the intervention of a non-conducting and incombustible hearth. Many gas-stoves, especially those used for cooking, require such protection equally with stoves burning coal and coke. A small gas-heated cooking stove set fire to the wooden floor under it in a block of residential flats in Westminster a few years since, and gas stoves similarly placed have caused many fires. (5) The setting of stoves in chimney openings is unfortunately not regulated by the new Act. Spaces are frequently left behind the sides of these stoves, and at the back of boxed chimney-pieces, where soot accumulates, which becomes ignited and communicates fire to the wood skirting and floor. Many buildings have been burnt down from this cause, and valuable lives endangered and lost. The Act should require all spaces at the back of stoves set in chimney openings to be filled in solid with non-conducting and incombustible materials. (6) In the second schedule of the Act, slate is recognised as a fire-resisting material when used for coverings or corbels. The treacherous nature of slate under the action of heat and fire before referred to, is here again altogether overlooked. A slate corbel, if it serves any structural purpose, would be most dangerous under the action of fire, and the general use of slate for the covering of roofs is largely responsible for the serious extension of many recent fires. Slate, when subject to heat sufficient to ignite wood, quickly crumbles and exposes any combustible material under it (which is often tarred felt) to the fire. Plain tiles are far safer, and cases are on record where tiled roofs fully exposed to large fires, have prevented the spread of fire, while slated roofs far less exposed to the same fires have allowed the buildings they covered to become involved in the conflagration. Slate should be struck out from the list of fire-resisting materials named in the new Act. Notwithstanding all structural precautions fires will occur in connection with the occupation of buildings if not from structural defects. A second line of defence is therefore required, for which it is usual to rely upon fire brigades and water supply. To

secure the fullest efficiency from fire brigades operating in districts crowded with large warehouses containing costly goods, the brigades should be provided with large scale plans of all blocks of buildings in such districts. These plans being suitably arranged for ready reference should, in addition to other information, clearly show all internal areas and openings, together with the size, position, and usual pressure of all fire mains, and the position of all valves and hydrants. These plans should be studied by the officers, who would first direct the operations of the brigade at a fire, and be by them from time to time compared with the actual buildings, so that an intimate knowledge of all difficult positions may be acquired. It is to be regretted that in London it has not been found possible to utilise the police more fully for fire protection as recommended by the Parliamentary Committees who have reported on the subject; failing this, the establishment of a fire patrol for districts crowded with large buildings fitted with costly goods is necessary. For the use of the members of such fire patrol, hose, handpumps, and other light appliances, near each hydrant, should be provided. Such a system would secure early discovery of fire and instant application of means for its extinction, so that many fires which now extend to conflagration would be extinguished in the room where they originated, at the same time earlier and fuller notice could be given to the nearest engine-station than is now possible. When the City of London first provided their admirable system of hydrants, it was contemplated that the city police would make use of these hydrants for the early extinction of fires in the manner above described. The omission to carry out this arrangement has certainly involved the citizens in very heavy losses.

Mr. Robert P. Notley writes:—I regret not being able to attend the meeting on this subject, but having had to survey to-day a large cabinet factory, it appears to me some facts I noted might be communicated if there is a discussion, or might be included with the report, as it is after all facts which are valuable. The building, No. 48, Bethnal-green-road, recently burned down (Monday night last), is about 60 feet high. It has, in two streets, fronts with considerable amount of window, and the piers between windows, which would otherwise be weak, are strengthened by possessing considerable thickness or depth, and by being corbelled out to receive floor timbers instead of being weakened by having the timbers built into them. Thus, in one street these piers are five bricks, or 3 feet 4 inches each way, and in the other street very nearly same depth. These two fronts are left by the fire perfectly plumb and practically uninjured. The back front of the building has piers about two feet or rather less in depth, and these are bulged by the fire so that they will require to be pulled down. The party walls have stood very well, and are only cracked slightly, and not injured materially. This is due, apparently, to the fact that the iron floor girders were not bolted to stanchions, and so were able to slide on them when expanded by heat. The new Building Act will require party walls to be carried up above warehouse roofs, in certain cases 3 feet—the wisdom of this is shown in this case. At extreme front and back on the side of the building in question towards which the fire set, the party wall is 3 feet above gutters adjoining, but only 2 feet at highest part of gutter. Here the gutter and roof of next warehouse is burned away, and the fire has run along towards the back of the next warehouse. At the front, the 3 feet has been sufficient protection, although where a wall at back is 3 feet high the roof is burned; it is less burned than in middle part, showing that it is here where wall was of less comparative height that the fire got over. These points about large or thick piers, loose bearings, and height of walls above roofs, appear very interesting in connection with prevention of spread of fire.

Notes on Books.

A Treatise on Ore and Stone Mining. By C. Le Neve Foster, F.R.S. London: Griffin and Co. 1894.

For practical and legislative purposes, mines in this country are divided into two classes—coal mines and metalliferous mines—underground workings for slate and stone being included in the latter class, which, for purposes of inspection, has latterly been enlarged, so as to take in open quarries. Professor Foster's text-book deals with all processes of obtaining minerals, except coal mining, which has been made the subject of a separate volume, issued by the same publishers. So exhaustive is the method adopted, that the list of minerals, which begins with alum and ends with zinc, includes not only amber, carbonic acid, flint, and petroleum, but even ice, a substance which is not generally looked upon as a mineral, however great its claims may be to be included among the other products of the earth's crust, which are so classified.

The first two chapters may be considered as preliminary; the first deals with the mode of occurrence of minerals, the second with "Prospecting." The accounts of chance discoveries and adventitious finds—occasions on which the search for one mineral led to the discovery of another—might, in all probability, have been largely extended, but, as it is, they include a number of strange stories, each sufficient in itself for the foundation of a romance.

The next part of the book deals with the extraction of the minerals in successive chapters on boring, breaking ground, supporting excavations, exploitation, haulage or transport, hoisting or winding

drainage, ventilation, signalling, descent and ascent. Under all these heads are described not only the systems usual in this country, but the various methods employed all over the world—on the European Continent, in America, Africa, and Australia. As instances of this completeness of treatment may be mentioned the description of the Siberian method of sinking shafts through ground charged with water. Towards the end of summer pits are dug down to the level of the watery beds; then in winter, when the ground is deeply frozen, the bottom of the pit is thawed to a slight depth, by means of a fire, and excavated. It is allowed to freeze again, the frost of course penetrating to a distance below the new surface. The thawing and excavating process is repeated, and the cycle of operations continued, till the shaft, surrounded by a casing of frozen soil, has been carried below the level of the water-bearing strata.

A chapter is devoted to dressing, on the ground that it is customary for the miner to cleanse or prepare his ore or stone for sale, even though, theoretically, the subject belongs rather to metallurgy than to mining.

The final chapters deal rather with the condition of the miner than with mining proper. Their subjects are—principles of employment of mining labour, legislation affecting mines and quarries, condition of the mines, and accidents.

The book has no less than 716 illustrations, besides a frontispiece, consisting of a reproduction of one of Mr. Burrow's remarkable underground photographs.

THE MIGRATION ON SYMBOLS. By the Count Goblet d' Alviella; with an introduction by Sir George Birdwood. Westminster: Archibald Constable and Co. 1894. 8vo.

The study of comparative symbolism has always been a fascinating one to archæologists, but many theories which for a time have found favour have been overthrown by the increase of knowledge. As the author, however, states, the situation has greatly changed during the last thirty-five years. "To-day we have everywhere at hand, in publications which will never be surpassed in importance and accuracy, the result of excavations carried on simultaneously in Chaldæa, Assyria, Persia, Asia Minor, Phœnicia, Egypt, and Libya, not forgetting the reproduction of memorials discovered or studied anew in Greece, Italy, India, the extreme East, and even in the two Americas." Working with the advantage of these accumulated researches, Count Goblet d'Alviella has been able to construct a clear and striking statement of the migration of various symbols, in the elucidation of which many remarkable facts are brought to light. He draws special attention to the double influence which is so often discovered in force when origins are sought for. He writes: "There is a tendency, in the first place, to reduce and abbreviate the figure in order either to enclose it in a smaller space, or else to lessen the work of the artist, especially when it is a complicated image in frequent use. . . . At other times, on the contrary, we have additions and embellishments suggested by æsthetic considerations. Such, in particular, was the fate of nearly all the symbols adopted by Greece, whose art, so powerfully original, never accepted foreign types without stamping them with profound and happy modifications." The author deals, among others, with the Gammadion or Swastika, the Symbolism and Mythology of the Tree, the Winged Globe, the Caduceus, and the Trisula, and points out that "the ancient world might be divided into two zones, characterised, one by the presence of the *gammadion*, the other by that of the winged globe, as well as of the *crux ansata*, and these two provinces barely penetrate one another at a few points of their frontier, in Cyprus, at Rhodes, in Asia Minor, and in Libya. The former belongs to Greek civilisation, the latter to Egypto-Babylonian culture." A Table is given which illustrates the migrations of the gammadion from the 13th century B.C. to the 9th century A.D., from which the curious result is obtained that although in its origin it was almost the exclusive property of the Aryan race, now, owing to its adoption by the Buddhists of India, the gammadion still prevails amongst a great part of the Mongolian races, but with the exception of a few isolated and insignificant cases which still survive amongst the actual population of Hindustan, and perhaps of Iceland, it has completely disappeared from Aryan symbolism, and even folk-lore. Other symbols discussed are the double-headed eagle found in Pterian bas-reliefs, dating back to the civilisation of the Hittites, and the Three Legs of Man, which first appears on the coins of Lycia, B.C. 480. Sir George Birdwood remarks in his introduction that "One of the most unexpected results of the critical study of these symbols is the establishment of their essential paucity. They undergo alike by devolution and evolution, and a sort of ceaseless interfusion also, infinite permutations of both type and meaning, but in their early monumental forms they are found to be remarkably few." The general conclusion at which the author arrives is that religious symbols common to historical races have not originated independently among them, but have been carried over the earth by conquests and commerce. Sir George says, with respect to this, "that the imprint of the Feet of Buddha on the title-page indicates the author's tentative opinion that the more notable of their symbols were carried over the world in the footsteps of Buddhism, or rather of that commerce of the East and West with Babylonia and Egypt, promoted by Nebuchadnezzar III. and Psammetichus I. respectively, out of which, through the internationalisation of Hinduism, arose in India, as later on, under the influence of the continued intercourse thus initiated between the countries of the Indian Ocean and the Mediterranean Sea, Christianity and Islam were successively developed from Judaism."

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock :—

December 12.—"Manufacture of Salt." By Thomas Ward.

December 19.—"Forestry." By Lieut.-Gen. J. Michael, C.S.I. Clements Markham, C.B., F.R.S., P.R.G.S., will preside.

Cantor Lectures.

Monday evenings, at Eight o'clock :—

Professor Vivian B. Lewes, "Modern Developments in Explosives." Four Lectures.

Lecture III.—December 10.—*Smokeless Powders.*—The early attempts to utilise guncotton, and the causes of their failure—The smokeless powders of to-day.

Lecture IV.—December 17.—*Blasting Explosives.*—Requirements—Fiery mines—A good safety explosive as great a safeguard as the safety-lamp—Explosives employed—The safety explosives now in use—Roburite, &c.

Juvenile Lectures.

Two lectures, suitable for a juvenile audience, will be delivered by Professor C. Vernon Boys, F.R.S., on "Waves and Ripples," on Wednesday evenings, January 2 and 9, 1895, at 7 p.m.

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 10...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian Lewes, "Modern Developments in Explosives." (Lecture III.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 6 p.m. Mr. Tonman Mosley, "The Control and Management of Public Roads."

Camera Club, Charing-cross-road, W.C., 8 p.m. Mr. G. Davenport, "The Electric Light for the Optical Lantern."

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Mr. James Macdonald, "An Adjustable Boot-tree." 2. Mr. Alexander Kirkwood, "A Sun-Dial Protractor."

Imperial Institute, South Kensington, S.W., 8½ p.m. Prof. R. K. Douglas, "China, and the Causes of its Present Disaster."

Surveyors, 12, Great George-street, S.W., 8 p.m. 1. Mr. William Sturge, "The Burdens on Real Property and Land." 2. Discussion on Paper by Mr. A. Dudley Clarke, "The Incidence of Taxation on Land."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Aubyn Trevor-Battye, "To Koiguef Island and Back, with some Weeks' Residence Thereon."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Silvanus Thompson, "Electric Engines."

Tuesday, Dec. 11...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Mr. Warnerke, "Photo-Engraving with Silver Salts."

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Sir Henry Wrexon, "The Ottawa Conferences—its National Significance."

Asiatic, 22, Albemarle-street, W., 4 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Dr. E. B. Tylor, "Some Stone Implements of Australian Type, from Tasmania." 2. Mr. Basil H. Thomson, "The Kalou-Vu (Ancestor Gods) of the Fijians." 3. Rev. Lorimer Fison, "The Classificatory System of Relationship, Australia."

Wednesday, Dec. 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Thomas Ward, "Manufacture of Salt."

Sanitary Institute, Parkes Museum, Margaret-street, W., 8 p.m. Dr. George Blundell Longstaff, "The Sanitary Aspects of the London Building Act, 1894."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Japan Society, 20, Hanover-square, W., 8½ p.m. Dr. T. Okamura, "Progress of the Judicial System in Japan."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Thursday, Dec. 13...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Imperial Institute, South Kensington, S.W., 4½ p.m. Mr. W. Somerville, "Some Aspects of British Forestry."

London Institution, Finsbury-circus, E.C., 6 p.m. Dr. J. F. Bridge, "A Popular Composer of the Olden Time." (John Jenkins)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Annual General Meeting. 2. Dr. C. S. du Riche Preller, "Electrical Steep Grade Traction in Europe." 3. Mr. H. D. Wilkinson, "Notes on Electric Tramways in the United States and Canada." 4. Messrs. R. W. Blackwell and Philip Dawson, "Electric Traction, with special reference to the Installation of Elevated Conductors."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, Dec. 14... Astronomical, Burlington-house, W., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science Schools, South Kensington, S.W., 5 p.m. 1. Prof. W. E. Ayrton and H. C. Haycraft, "Students' Apparatus for Finding the Equivalent of Heat." 2. Prof. W. E. Ayrton and E. A. Medley, "Glow-lamp Tests, and the Measuring Instruments."

Corrections :—Page 25, col. 1, line 10 from bottom of page, *omit* per square inch.

Page 35, col. 2, bottom of page, *for* $V^2 \times \cdot 500 = P$, *read* $V^2 \times \cdot 005 = P$.; *for* 2175·28 *read* 2173·28.

Page 37, col. 2, *for* Mr. Anson, *read* Mr. C. J. Whistler Hanson.

Journal of the Society of Arts.

No. 2,195. Vol. XLIII.

FRIDAY, DECEMBER 14, 1894.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 2 and 9, 1895, by Professor C. Vernon Boys, F.R.S., on "Waves and Ripples."

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. The cards are now in course of issue, and members should apply at once.

CANTOR LECTURES.

On Monday evening, 10th inst., Professor Vivian B. Lewes delivered the third lecture of his course on "Modern Developments in Explosives."

The lectures will be printed in the *Journal* during the Christmas recess.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

INDIAN SECTION.

Thursday, December 6, 1894; the Earl of Carlisle in the chair.

The paper read was—

THE ROMAN AND BRITISH INDIAN SYSTEMS OF GOVERNMENT.

By W. Lee-Warner, C.S.I.

I must at the outset appeal to the indulgence of my audience, and ask them to make liberal allowance for the task I have somewhat rashly undertaken. The invitation of the Society reached me on my return to England for a flying visit of eight weeks, and I have left behind me in India all my note-books and books of reference. I am not so presumptuous as to suppose that my schoolboy and university acquaintance with Roman history deserves your attention, but I hope that my service in India for over a quarter of a century may enable me to give you a sketch of its administration, which will suggest to you some interesting contrasts with Roman methods. Forty-two years ago, Arnold wrote these words :—"We are doing Elphinstone's 'History of India' in the VIth. It is a pity that Elphinstone had not a more profound knowledge of the ancient Western world, which continually illustrates and is illustrated by the state of things in India." I cannot compete with Elphinstone in Roman history, and even as to India I must speak with diffidence. For throughout my service in the East my sense of the magnitude of the responsibilities which our country has undertaken in India has only been deepened, and the facts and views which I shall venture to present to you are put forward in the full consciousness that opinions differ upon every set of facts, and that I can claim nothing except a full appreciation of the difficulties of Indian administration, and an earnest desire not to misrepresent the situation. It has always appeared to me that history is the education of the human race, and whether the Roman Empire forms a parallel, as some think, or a contrast, as it seems to me, to our Indian dominion, its methods of dealing with the very problems which face us in India deserve attention. It may seem impossible to bring into the same plane of view the old and the new empires. But the railroad and the

telegraph annihilated geographical distances, and brought Bombay nearer to London than Athens was to Rome. Our knowledge of Roman systems has also increased, and with the requisite correction in his focus, the eye of the statesman can look from the foreground of Indian administration down the vista of eighteen centuries to the extensive dominion which spread from the slopes of the Apennines both to the East and to the West. I propose this afternoon to invite your attention to the qualifications and the powers of the agents whom Rome employed in its provincial Government, and those of the civil servants whom we employ in India. From a brief review of the external policy of the two great empires, I shall pass to a consideration of the nature and aims of their internal administration. This may suggest the question whether our rule in India is popular or the reverse. I shall conclude with some brief remarks upon religion, that most potent influence as a moral agency for the regeneration of any society, and shall refer to the present religious attitude of India.

The Governors and Civil Services.

Dealing first with the Roman system, I want to recall your attention to the methods by which the provincial governors and their subordinates were recruited, to the centre from which they drew their principles of administration, the general character of their policy, and the soil in which they planted Roman institutions. As you are aware, Rome under the republic and Rome under the empire were very different. The Senate appointed the republic's officials. Under Sulla's constitution the two consuls and eight prætors of Rome became, by virtue of the prorogatio, proconsuls of provinces which needed a military force, and propraetors of the peaceful provinces. The consuls and prætors were elected by the assembly of centuries, after a very expensive canvass, and they served as Roman magistrates without pay for a year. The Senate having appointed its provincial governors, sent them forth to govern. At the conquest of the province the Senate had appointed ten legates to draw up with the conqueror a charter (*lex provincialis*), and it further directed its governors how to act. If they were charged with maladministration they were subject to trial. But, with these safeguards, the governors had a free hand. They raised troops, collected the tribute, and in their edicts declared the code of law and procedure which they intended to follow. The provinces had been conquered by Rome, and the Senate knew that during their brief term of office the governors expected, not merely to repay their election expenses, but also to amass enough money to bribe their judges, if they were impeached, and to make a fortune for their lives. With the governors went out a financial secretary (*quæstor*), a certain number of senatorial legates, and a large circle of personal friends (*cohors*), with a strong staff of clerks. The towns *en route*, as well as those in the province, entertained this army of subordinates at the public expense. Armed with military authority or imperium, the governors could enforce whatever it pleased them to order. In the wake of their progress followed the tax collectors or *publicani*. I have mentioned that the governors might be impeached after their term of office. It was all-important then to conciliate the judges who would be either senators or knights (*equites*). The senators hoped to become governors and might be trusted to be lenient, but the knights required another inducement. From their ranks came the tax contractors (*publicani*), and a wise governor assisted them with his troops to enforce their demands. They advanced real or pretended loans to the municipalities, and we learn that Brutus once starved to death five municipal councillors of Salamis to recover interest from the town at 48 per cent. Sometimes the Senate appointed commissions of inquiry (like our Parliamentary commissions) who made a profitable business, and occasionally went to a province merely to collect bad debts. To be brief then, the governors under the republic were men who obtained a short term of office in order to plunder the provincials. Their civil service consisted of their own friends or the friends of their Roman patrons. The military authority was chiefly used for the extortion of interest, and in the words of Cicero, which are perhaps tinged with some rhetorical exaggeration, "No legal decision was given on any other grounds but the governor's will, no inherited property was safe, enormous sums of money were exacted from cultivators, men were prosecuted in their absence, justice was sold, public statues and ornaments were robbed and temples plundered."

The emperors put an end to this wholesale plunder of the provinces by governors, civil servants, and tax contractors and their friends. They introduced a better organised administration, but they also organised

plunder for imperial needs. The Roman citizen paid no taxes because the provinces supplied the tribute, customs dues and other levies. The Roman proletariat was kept quiet by free doles of food which the provinces supplied. Tiberius could only restrain a too active governor by the cold-blooded remark, "that a wise shepherd shears but does not flay his sheep." At first the governors of the peaceful provinces were appointed by the Senate as formerly, while the emperors chose the legates for Syria, Cilicia, Cyprus, Egypt, and other frontiers or disturbed districts. But eventually the emperors assumed the government of all the provinces, and even before that date they nominated the revenue commissioners (*procuratores augusti*) of the senatorial provinces. Under the empire then the provincial governors and the civil service were the nominees of the emperors, and you all know what the character of their masters was. No doubt a system of organised taxation, however crushing, was preferable to the cruel competition for plunder under the republic, but to the very end the question which Civilis asked of the Treverians would have applied to the provinces of the empire, "What reward do you expect for having shed your blood so often, except hard and unpaid service, eternal tribute, rods, axes, and the caprices of your rulers?"

Whence did these officials and their subordinates draw their instructions and inspirations? From a country and a capital placed geographically in the very centre of her empire, which thought only of Rome's needs and Roman privileges, from one which ruled on the principle of *divide et impera*, from emperors who felt the pressure of the barbarians upon the too extended frontiers of Rome, from the clamours of an idle populace at home, from the centre of a military despotism tempered by no free Press, associations, or Christian influences at home, and checked by no conservative civilisation such as we encounter in India. The provincial policy reflected the unmerciful selfishness of Roman rule. In the provinces themselves there was no influence to counteract the sterile policy of Rome. Greece alone had, by the force of her literature and culture won a victory over her conquerors, but the rest of the provincials were "barbarians" in Roman eyes. They yielded themselves in silence to the shearer, and, as Guizot remarked, the provinces "left few traces not only of popular resistance, but even of sufferings."

From this brief and imperfect sketch of the Roman governors and their subordinates, let us now turn to the *personnel* of our Indian administration. I must, in passing, notice the great power for good or evil which British subjects, who are not officials, exercise in India. Our merchants and men of business help in a material degree to govern India. They create a local opinion which may be, and often is, a great factor for good. If their relations with the natives are kindly they can do much to win for their country the hearts of the people. Their opposition to Government, combined as it is with loyalty to their country, whenever it is dictated by public spirit and sound judgment, is itself an education; and their courage, enterprise, and probity in business help to command respect for the qualities of the race which rules the country. But their operations are confined to certain centres of vast India, and since this paper is meant to draw contrasts there is no element in the Roman empire with which I can compare this influence. Rome had no merchants to send out to the provinces, and she gave nothing in return for the tribute she took, except the public works, the law, and the administration which her officials supplied. I must therefore place opposite to the picture I have drawn of Roman rule a sketch of the rulers whom this country sends to India, the principles it inculcates, the policy it dictates from a distance of more than 6,000 miles, and the soil in which it plants and nurtures its western institutions. You will not forget how singularly disengaged by distance, religion, and civilisation our country is from the empire we rule, and what obstacles must meet, and even thwart, the virtue that goes out from our Christian islands. With these hints, I proceed to present to you a view of the governors and and civil servants who do your work, and perform this country's noble mission in the East Indies. For five years at a time, the supreme Government of India and the Governments of the two provinces of Bombay and Madras are entrusted to statesmen of eminence sent out fresh from England. They live in the full glare of public opinion. They are chosen from all parties, and they have no power to interfere with the action of law or of justice. Frequently the governors chosen by one party have to serve under another party in office here. Their subordinates are not chosen by themselves; they are even strangers to them. For their laws they must depend, except in the gravest crisis, upon the

slow movement of legislative councils. They have no tribute to remit to London, and their success is judged by an annual record of the moral and material progress of India which is not compiled by themselves, and is criticised by their political opponents. The administrative service under them consist of three ranks, the Imperial civil service, the Provincial civil service, and the subordinate services. The first is the supreme directive service of the empire, composed of men recruited by public competition, with the exception made in 1870 by Statute 33 Vict. cap. 3, which allows the appointment to certain offices of natives of India of approved merit and ability without having entered the service by the door of public competition. This Imperial service is now reduced to the smallest dimensions possible. It numbers less than a thousand, and, excluding those serving in Burma or learning their work, the average charge of each civil officer is 1,004 square miles, with control over a population of 274,279. So long as India is to be governed according to a British standard of administration, the retention of this irreducible minimum of public offices in British lands seems inevitable. In the higher provincial services some 2,600 persons are employed, of whom, as reported by a recent commission, only 35 were Europeans, not domiciled in India. In the civil posts, carrying salaries of 1,000 rupees and upwards, out of 114,150 appointments tabulated by the same commission, 97 per cent. were held by natives of India. The permanent British official element in India, with its 221,000,000 of British subjects, and its 66,000,000 of protected subjects of native States, is therefore represented by some 765 British officials, selected by public competition in London. Who are these men upon whom the progressive administration of India under its viceroy and governors depends? They are gathered in by open competition from every class of British society. They include representatives of all our public and private schools, all our universities and training institutions. They carry to India every shade of political profession and religious sect. They return to Europe to mix on furlough with every variety of thought and sentiment. They represent no personal policy of an emperor, they are educated in no single Haileybury College, they are not the sons or *protégés* of previous Indian officials, and the only source from which they draw a common inspiration is our many-sided British life, with its insularity corrected by commerce and intercourse with the world. Nor is their individuality reduced at a later stage to a common denomination. The exigencies of the public service admit of no restrictions on their free development when they arrive in India. The small contingent of recruits which year by year reaches Bombay is at once scattered through the empire. The departments of the public service, judicial, executive, finance, and magisterial, tend to develope a still further variety of view and temperament. The minute parties into which British official society is broken up in India prevent any uniform solidarity, whether of prejudice or preference. Independence is secured by the conditions under which the service is entered, and its promotion gained. There is an honourable consciousness that the official owes his appointment to no personal favour, and that he is devoted to the service of the State for his lifetime. The phrase which is sometimes used, an Anglo-Indian bureaucracy, seems to me singularly inappropriate to a few hundred officials gathered from all parts and parties of the home market, plunged at once into isolated stations in vast India, and allotted to different tasks in its complicated and multiform administration. Of politics, in the British sense, the Indian civilian happily knows nothing. His choice of a party is usually reserved till he retires from the service. His duty is owed to no Imperial master, but to Great Britain, and his loyalty is rendered to the changing viceroys and governors whom the various parties at home despatch to India. Let us now look at the centre whence these officials draw their instructions. The improvements of communication keep the Indian civilian in contact with the drift of public opinion at home. His knowledge of the people of India and of their life compels him, however, to adjust the views of England to the facts of India.

To that extent he may seem to an impatient reformer to lag behind the spirit of the age. In these days of the telegraph there is a hurry and a general readiness to jump to conclusions of importance. The British nation dislikes suspense and indefinite conclusions, it forgets at times that the mind must be shaken free from our insular experience, and it is apt to be impatient of the laborious process of gathering evidence and facts. The forces which move Indian society are not those which have emerged from our constitutional struggles and our free social life. The Indian officials have not ceased to be British because they serve

their country in the East, nor has the variety of their early training and subsequent associations suddenly converged into a uniform opposition to British ideas. They are not the subservient instruments of Imperial policy, recognising, as the Roman governor did, that all authority was either exercised by the Emperor or visibly proceeded from his prerogatives. The catch-phrase, "Anglo Indian," suggests too hastily an idea of homogeneity which does not exist. The Indian civil servant must and will obey the orders of his country: but he must watch two barometers of public opinion, and he does not cease to sympathise with British aims, as is sometimes imputed to him, because he is compelled to feel the pulse of Indian opinion. May I humbly venture to impress upon a London audience their responsibility, as well as that of my own service, for the conduct of Indian affairs? In the last resort Indian officials must obey the mandate of British opinion, and therefore no account of the Indian civil service is complete without a reference to the sovereign authority of Parliament and of the forces which act upon that body. The power which the Roman emperors, so centrally situated, could exercise through their legates and subordinates upon the fortunes of the provinces, was not more potent than that which Parliament can bring to bear on India notwithstanding its greater distance from the centre. The discoveries of steam and telegraph have given public opinion here a grip upon India. Let it not be said then that the interests of one-fifth of the world's reputed population are subordinated to the selfish objects of political parties at home, or to those of our national trade. The spell by which we have held the Indian empire is the belief in our justice and generosity, and at this moment the question is being anxiously debated in India, whether the interests of Manchester, in the matter of the cotton duties, will outweigh those of 287,000,000 of your Indian fellow-subjects. Hitherto India, governed as she is by men carefully selected by examinations held in this city, has regarded public opinion in England with its free Press and its Parliament as its surest defence, and a shock would be given to our rule if anything occurred to weaken its confidence in the virtue that proceeds from this centre of British power.

I have dealt with the *personnel* of our officials, with their aims and the control of British public opinion, but there remains one feature which emphasises the contrast between the Roman and the British Indian empires. I refer to the character of India itself. The Roman nowhere outside the small country of Greece encountered the resistance which Indian society presents to the impact of Western civilisation. India is a country not merely of conservative institutions and of passionate religious feeling, but it has a developed civilisation of its own in violent antithesis to the liberal institutions and freedom of this country. The flashes on the surface, the congress meetings, and the repetition from Press and platform of familiar cries and catchwords borrowed from the London Press are not India. Of the male population numbering 146,750,000 only 14,500,000 are learning, or have ever learnt, to read or write. Of 140,500,000 of females not 750,000 can be similarly classified. Despite superficial appearances the soil of India has hitherto presented an ironbound resistance to European influence. Anxious, as we all are, for social reform, we must not misread the earnest appeals of a few Indian reformers, who turn wistfully to England for a support that is denied to them by their own countrymen, or the exaggerated utterances of a young Press, which needs the indulgence usually accorded to undergraduate eloquence. We carried the abolition of suttee, and, more recently, the Age of Consent Act, against the weight of Indian public opinion. Were our power removed, widows would again be burnt on their husbands' pyres. The recent outburst of religious riots tells the old, old story. It is the escape of flames which smoulder beneath the crust of the *pax Britannica*; and if the country was not disarmed, the streets of Bombay and Poona would lately have flowed with blood. The Romans nowhere met with such a power of passive resistance as our civilisation encounters in India, with its village organisation, its widespread ignorance, with the hold which its superstitions and faiths exercise on the public mind, and with the confusion of its 81 languages. The position is aptly described by Matthew Arnold in lines which, though applied by him to Rome, are more correctly applicable to the India of to-day:—

> The East bow'd low before the blast
> In patient, deep disdain;
> She let the legions thunder past,
> And plunged in thought again.

The Western yeast has no doubt begun to work, but the ferment has at present reached only the surface of a corner of society. The conservative forces of native society are a factor

in the present situation with which Indian officials must deal, and British opinion must recognise their force.

I must now pass on to the next division of my subject, the contrast between Roman and British policy in

The Conduct of External Relations.

From the Act of Parliament, in 1793, to the Queen's Proclamation of 1858, the pursuit of schemes of conquest has been declared by Parliament to be "repugnant to the wish, the honour, and the policy of this nation," and the maintenance of the rights and privileges of the native States of India has been solemnly guaranteed on the condition of loyalty and their observance of treaties. That guarantee has been respected by us. Yet Great Britain has stood face to face with no lighter difficulties or temptations than those which assailed Rome. Her avoidance of Roman precedents has been the secret of her success. We may follow, for a short distance, the course of Roman annexation. From the outbreak of the first Punic war (B.C. 264) commenced the career of Roman conquest outside Italy, and every addition to the Roman dominion involved extended obligations and fresh dangers. Colonies of soldiers were planted in the new territories, retaining their *civitas*, and, in course of time, developing into municipia. The extension of the limited privileges of Latin citizenship, first to Latin cities, up to B.C. 89, and thereafter to peoples and cities outside Italy, was the next step to annexation. A few states were honoured with treaties, which lasted only so long as they suited Roman policy. In the end, an aggregate of these several units (or *civitates*) was formed into the province, and the very phrase used—*in formam provinciæ redigere*—suggested the subjection to Rome, which the grant of a provincial constitution implied. Whilst the treaty-states lasted, they supplied military contingents, and maintained them in serviceable equipments at their own expense. Much praise has been lavished upon the gift of municipal self-government by Rome, but like all her gifts, including that of the *civitas* which Caracalla extended in the third century after Christ to the inhabitants of the whole empire, when it had lost its value, municipal privileges were obligations rather than rights. Municipal office became such a burden to the local senates (*decuriones*), that it was a mark of privilege to be exempted from it, and Ulpian tells us that the office of a *decurion* was even made hereditary. Generally speaking, the Roman empire brought under its direct rule whatever it was profitable to annex; and mercilessly used the cities or peoples which it left with some degree of authority as its authorised agents for the collection of taxes, or for the supply of Imperial needs. Its idea was that protection implied subjection, and it gave no gift or treaty without an equivalent.

The fact that India to-day includes 604,717 square miles, and more than 65,000,000 of people subject to their own rulers, is the best answer to those who would charge the British with having pursued a Roman policy. The truth is, that despite the victories of Clive, Wellesley, and Hastings, and the annexations of Dalhousie, the oldest sovereignties of India, and many of the richest provinces of the country remain under the protection, but not under the dominion, of the Queen Empress; and this result has been attained by deliberate modifications of our external policy to suit the conditions of the country. And here I venture to notice a criticism upon a book which I recently wrote on the "Protected Princes of India," in which my critic observed that the year 1813 was not the real landmark of a change of policy. I readily admit that at any attempt to divide history into periods needs the admission that the shadow of a change is cast upon the pages of the years which precede it. Lord Wellesley, no doubt, anticipated the policy of Lord Hastings, but the interval which elapsed between the two governor-generals, and which was filled up by the reactionary policies of Lord Cornwallis and his successors, justifies me, I submit, in fixing 1813 as one period—the period of policy of non-intervention, or, as I have elsewhere ventured to call it, the policy of the ring fence. The essential features of this period were the treatment of the Indian sovereigns as independent princes entitled to be regarded as subjects for international rights, a strict avoidance of all interference with them, and the extension of British engagements with them to the most limited extent. Two results followed. The chiefs admitted to alliance were not advanced enough to understand the meaning and responsibilities of equal States, or the heavy international penalties of a breach of treaty. The chiefs left outside the ring fence proved bad neighbours to the British, warred with each other, and afforded shelter to the enemies of the *pax Britannica*. The position was intolerable, and would have been terminated under the

Roman empire by the advance of Roman legions. The British Government met the situation first by suppressing the Pindaris, and then by an alteration in its policy. It covered India with a network of honourable alliances, it adhered to its promise of non-intervention in internal affairs, but it deprived its allies of all rights of war and political commerce with foreign or other Indian States. This policy, which was one of subordinate isolation, lasted till the Mutiny. Its defect lay in the principle bequeathed by the former policy, a principle of too rigid non-interference in internal affairs. The mismanagement of some of the country princes was intolerable to the British and to the subjects of the native sovereigns. War was declared upon Coorg, the King of Oudh was required to abdicate, and so impressed were the authorities by these examples of misrule that they thought it their duty to annex states whenever their rulers had no lineal male descendant to succeed them. A generous public opinion in England came to the rescue. If it were necessary to choose between an abandonment of the extreme doctrine of non-interference, and annexation as putting an end to grave misrule which the paramount power could not honourably tolerate or support with its alliance, clearly the interests of the native states required the former. Accordingly Her Majesty, in assuming the government of India, issued her sanads of adoption, and promised to perpetuate the governments of the ruling princes on condition of loyalty and faithful adherence to their obligations to the British Government. The noble Viceroy who conveyed this assurance explained, in his minute dated April 30, 1860, that the Government of India would be free to step in "to set right such serious abuses in a native government as may threaten any part of the country with anarchy or disturbance, or assume temporary charge of a native state when there shall be sufficient reason to do so." By these successive changes of policy the integrity of the country-sovereignties has been preserved. The British law, which, as in the Roman empire might have "reduced the states to provinces," has not encompassed the native states: their military and diplomatic relations have been clearly defined: and, as time goes on the duties which they owe to the paramount power in the conduct of their internal affairs, are being classified and regulated with the single aim of avoiding interference and promoting friendliness.

There seems to me no department of the Indian Government which presents such a contrast to Roman administration as that of the Viceroy's Foreign Office. No doubt all danger has not passed. The increasing influence of English opinion upon Indian affairs will be apt to force the pace, and to exact more from the rulers of the native states. There are those, for whose opinions I have the greatest respect, although I do not share their views, who would introduce the native states into the British Indian system, giving to their rulers a voice in the councils of the empire, and uniting the whole jural systems of British and native India by a sort of federal Supreme Court and an Imperial Code. No doubt some anomalies would then be removed. The right of Europeans to be tried by European Courts, and the anomalous residuary jurisdiction exercised by the Courts of the Governor-General in Council in or in respect of persons and places outside British India would not be necessary, if all India, like the United States of America, entered into a federal jural union. But I venture to think that the vast variety of the native states and their conservative tendencies oppose an irresistible barrier to such a programme. I would rather follow the advice of Sir John Malcolm, and not "disturb native states with laws which they do not understand or dissolve ties which, when preserved, further our objects. By tolerating what we deem misrule, and by conciliating those who possess the hereditary attachment of tribes, we may render them instrumental in reforming their adherents." We must interfere at times to prevent gross misrule, but we should support to the last moment the theory of sovereignty, and only detract from it for a season the parts essential for one object. The only theory upon which we can build up a system of rights is Maine's theory that sovereignty is divisible into substantial portions, some of which can be left to the protected princes without entirely destroying their claims to be treated as sovereigns. I know that Austin and a recent reviewer contest this position, but Sir Henry Maine understood well the position of India; and I venture to think that our conceptions of phrases like "sovereignty" or "international law" must accommodate themselves to existing facts, if the science of interstatal or of international law is to be one of practical living power No chief can reform his administration if his authority is weakened by constant appeal and interference from outside. Intervention should be the last resort, but when it is inevitable it

should be thorough and limited to its essential objects. The reform of the judicial system is generally desirable, but it is an internal reform which must advance *pari passu* with other reforms, and proceed from within. We can set an example with our own laws and our own administration of justice, and when we suppress for a time a native sovereign's powers we can, as Lord Harris lately did in Cambay, establish courts, enact laws, introduce a survey settlement, and re-organise every department of the native state. But beyond this it seems to me that we should avoid a policy of benevolent coercion. We should be tolerant but firm, patient yet encouraging reform, and we should continue to show that we are as able to preserve the rights of our allies as to maintain with a Roman inflexibility our own rights.

I pass on now from this brief review of our external relations with the allies to a general view of the conduct by Roman and by British-Indian administrators of

THE HOME DEPARTMENT OF ADMINISTRATION.

Three features of Roman internal administration strike one in the perusal of Roman history — the concentration of all authority in the hands of subservient governors and subordinates chosen by themselves, the harshness of their revenue system, and the absence of all sympathy and of any desire to promote the moral or the intellectual welfare of the subject peoples. Once more I find only a contrast between the methods of Rome and Great Britain. I need not repeat what I have already said as to the absolute rule of the emperors, the slavish subservience of their subordinates, the selfish spirit of Roman provincial government, the constant interference with the courts of law, the absence of an independent legislature, the bestowal with niggardly hand of the rights of citizenship, and the loading of such honours as were given with onerous duties, so that the monuments over the dead record that they died *oneribus honoribus functi*. The governors tolerated no public criticism. They viewed with distrust any associations of their subjects. Trajan refused to incorporate a company of 150 firemen for the use of the city of Nicodemia. The Proconsul Pliny issued an edict against unlawful societies and public meetings, and the Christians were persecuted to death less because of their religious tenets than on account of their religious convocations. As to the weight of taxation and the cruel methods of enforcing payment, we must recollect that it was an age of slavery, of disregard of life, and of gladiatorial shows. But humanity revolts against the sale into slavery of children for arrears of taxes due by their fathers.

Then as to the general tendencies of Rome's rule over the provinces, the prayer of Tacitus will occur to you, "May the nations continue if not to love us at least to hate each other." The administration was regimented on lines of self-interest, but the emperors never discovered the secret that national finances benefit by the progress and prosperity of the people, and that in the moral improvement of the provincials and their participation in the administration lay the only road to progress. We hear much of the rights of Roman citizens and of Rome's empire, but nothing of the rights of subject races and of Rome's moral responsibility for a great trust committed to her care.

It is pleasant to turn to the higher conception of the duties of empire which our Christian and liberal institutions have laid upon us. Our Indian officials are subject to four influences which were not felt by the Roman governors and their subordinates. There is a free Press and an expression of public opinion, halting and in its infancy in India, but still to be reckoned with as an active force, and all powerful and outspoken in Great Britain. The telegraph and the regular post unite these two forces and bring their weight to bear upon every district officer. A Christian enthusiasm and a high moral standard of duty correct selfish motives and widen our view of political obligations; while in the fourth place a system of competition gives independence and variety to the public service. Let us see how these influences affect our programme of internal administration in respect of three great duties—the maintenance of the public peace, the education of the people, and the promotion of their material welfare. Our own countrymen experienced on the Grampians and in Wales the methods of Rome, and Calgacus pithily said—*Solitudinem faciunt pacem appellant*. We, too, in India have to stand to arms along a frontier of some thousands of miles. We owe the peace we enjoy less to frontier expeditions and to military posts than to the victories of peace. We have won the hearts of our Pathan and Biluchi neighbours by the establishment of hospitals on their borders, the free grant of land and canal water for cultivation, and the establishment of fairs for peaceful intercourse

and commerce. Within our borders we have endeavoured to compose religious feuds, to promote religious tolerance, to attract to schools the Bhils and other aboriginal races, and to bring the classes together by uniting them if possible in the task of self-government. The instruction of the people in schools is but one part of our educational system. In 1881-82 there were in British India 94,989 educational institutions, attended by 2,451,982 pupils. In 1891-92 there were 141,793 institutions with 3,856,821 pupils. Mahomedans have during the last five years increased by nearly 18 per cent., and girls at school by 27 per cent. Universities have been established at five centres, that at Allahabad having been inaugurated in 1887. Technical institutes, developed principally by Lord Reay, and fostered by his successor, have already proved their value, and the improvement of agriculture has been taken in hand. In 1881-82 the total expenditure on public instruction was 186 lakhs of rupees, and eleven years later it was 317 lakhs, an increase of 70 per cent. But the greatest point of contrast between Roman and British policies is our attempt to bring the people together in the conduct of local affairs. The legislative councils have lately been enlarged, and local bodies are invited to nominate councillors for appointment by the Viceroy and the governors. Then there are the municipal and rural boards. In 1891-92 there were 755 municipalities in British India, and 9,150 of their members were natives. There were 6,474 members of district boards, and 7,263 members of sub-divisional rural boards. It must be freely admitted that without the power of nomination, reserved by Government, many of the most important classes of the community would not be represented at all, and our attempt to weld the people together in the task of self-government would be futile. In particular, the Mahomedans would be left out in the cold, and amongst Hindus one caste only would be represented. But time and education will, I trust, correct this inequality. The public revenues raised by rates and provincial contributions, which are administered by these boards, are considerable; and although in many districts the interest taken in elections or local administration is not conspicuous, one is entitled to point to the network of self-governing bodies established by us as a disinterested and noble experiment in Indian administration. The introduction of the jury system is another direction in which we are seeking to educate the people. I cannot here dwell on the extreme difficulty of extending it. The paucity of qualified jurors, and the deep-rooted religious prejudices or caste influences which affect their judgment, are difficulties to be faced. You are aware that the doctrine of transmigration prevails in Hindu society, and in Anglicised Bombay there are well-educated gentlemen who would not kill a flea or any other animal. A horse with a broken leg cannot be shot without the gravest shock to public sentiment, and you can judge for yourselves how impossible it is for an Ahmedabad jury to find the most brutal murderer guilty of murder and so subject him to capital punishment. The prevalent belief that a woman should not accuse her husband led in one case that came before me some years ago to a nominal sentence of 24 hours simple imprisonment, where a man, aged 30, deliberately broke the arm of his young wife of 13 years of age, notwithstanding the expostulations of his neighbours who, however, confined their interference to advice. We must necessarily pause before we extend a jury system to a society which regards so lightly the rights of women, and we must be content to wait until a clearer sense of public duty and private rights exist.

I have glanced at our methods of maintaining the public peace, and the more difficult task of educating the people, and I must pass on to our endeavours to promote the physical and material welfare of the Indians. There is an abnormally high birth-rate in the country, due to the universal practice of child marriage. The stream of infant life which results has to do battle against epidemic diseases, climatic changes, and neglect of sanitation, as well as recurring famine. We can attack the enemy by the provision of hospitals and dispensaries, by extending railways so as to bring congested or famine-stricken tracts within reach of fertile provinces, and we can do a little to fight against the rooted dislike of sanitary precautions and pure water. Here it is that we encounter the full strength of that Asiatic resistance to Western methods to which I have already referred as a force which Rome did not encounter. Our higher conception of duty compels us to try and save the people from themselves. We punish the people for washing their dirty clothes in the drinking wells, we control their religious fairs when cholera breaks out, and in time of famine we save lives by the sternest discipline. We have also tried to give variety

to the industries of the people. We have taught the Indians the value of their coal fields, we have conserved their forests, relieved the pressure on the land by teaching them to spin and make cotton goods, and urged them by new methods to improve their agricultural stock and to get more out of the land. But every change has its disadvantages. The native industries and methods perhaps deserve to perish, but they *do* perish, and the carriers with their pack bullocks or the weavers with their hand looms suffer in the competition with railroads and the 127 mills which have grown up like magic. We conserve the forests for the benefit of the whole country, but the forest tribes will not thank us, and the general population hardly knows what we are doing. I need not run through the whole list of our measures for increasing the physical and material welfare of India. Like our moral and social programme the steps we take to husband or improve the resources of India are sure to encounter opposition in the Press and in the village, and if we are to succeed we must rely upon the steady support of British opinion and the efficiency and sufficiency of the bare regiment of British officers who govern an area of 964,993 square miles in British India, and advise and assist the rulers of some 600,000 square miles of native states.

I may perhaps pause here to answer a question so often raised.

Is British Rule Popular?

In the first place we are foreigners, and in the second we are schoolmasters; and we can hardly expect that the heart of many races, so much at variance with each other, should come forth to meet us with a wave of gratitude and sympathy. Not long ago I heard the greatest Hindu of the present generation, the late gifted Mr. Justice Telang, hissed in the Bombay Senate-house because he had supported the Age of Consent Act. Yet he was a patriotic Hindu of Hindus, whose health broke down in the conflict between his loved Aryan civilisation and the force of Western ideas. In forming any opinion as to the popularity of our rule, we must draw a distinction between the sentiments of the masses and the sentiments of the classes. The spell which we exercise over the masses is British justice and impartiality. But as we recede from the past the lively memory of the injustice and disorders which we have replaced fades more and more from the mind, and the increasing condemnation of British rule, which proceeds from the vernacular Press, reaches a larger audience. Our very impartiality in the religious riots which have of late revived brings us into collision with the excited prejudices of both the communities who may be in conflict. I have also heard it remarked by many Indians that the substitution of native magistrates for British officials weakens the confidence of the ignorant masses in our administration of justice, especially since it happens that these magistrates are mainly drawn from one class of the community. All this we must expect, but I have no doubt that the blessings of the British peace and British justice are widely appreciated. I prefer to quote in this connection from a thoughtful article written by Mr. R. P. Karkaria in the last *Calcutta Review*. "Simple as the peoples of India are they are not so foolish as to think that the millennium will be reached when the Bengalee shall rule the Punjab, and the Mahratta lord it over Bengal; when the Sikh shall sway Gujerat, and the Banya and Borah keep in check Rajputana; when the Madrassi shall represent the supreme authority in Sind and Biluchistan; and the Pathan and Biluch deal justice in Travancore." "The moral sin of which England is guilty is that of governing 300,000,000 creatures in every way better than they have been governed in the past or can govern themselves at present, or any time in the future." That I believe to be the general conviction of the masses who still have the native states to look to if they want to see a type of home-rule. With the educated classes the case is somewhat different. Education has for centuries been the monopoly of a few castes, and they cannot help feeling the drift of our rule from status to contract. Privileges cannot be threatened without sore feelings, and although the higher castes and classes still hold their own under our system, they know that a consciousness of their own rights and potentialities is being awakened in the minds of intelligent men of other castes. Our efforts to raise the low castes are bitterly resented, and grave offence to the privileged classes is caused by the endeavours made by Government to give a fair representation in the public service, and on the boards of municipalities and districts to all important sections of the community. Then again the aspirations of the few are opposed to our policy, and the gulf only widens as further concessions are made. M. Karkaria, from whom I have just quoted, writes of what he terms wild

political critics in these terms:—"With their impossible demands; with their specious loyalty and deep-rooted hatred of their foreign rulers; with their preposterous search after the phantom of premature political advancement before attending to the crying need of social and moral reform; with their uncompromising attitude of stern hostility to the entire official class; with their fruitless criticism of all the acts of Government, and their malicious imputation to it of false and unworthy motives." There is both truth and exaggeration in this picture. Political abstractions founded upon English facts are no doubt being applied to a society which, as Sir Henry Maine observed, belongs, through nine-tenths of its structure, to the thirteenth century of the West. I have heard a solemn discussion in Poona upon the preposterous idea that British troops should remain in India, to maintain order, and the 800 civil servants of the Crown should be replaced by native officers, which practically means by representatives of the classes. Aspirations such as these must be disappointed, but their discussion is not wholly an evil. The intellect of India is to some extent awakening from a long sleep, and it is good that it should try conclusions with hard facts. Its Press is, at times, scurrilous and thoughtless, but its very exaggerations and misrepresentations may perhaps work their own cure. The truth will ultimately settle down, and the Indian reader is already getting tired of the crude and reckless language of his ill-conducted newspapers. On the whole, the antipathy to British rule which the vernacular Press exhibits does not, I believe, represent the bulk of the opinion of the educated classes, who are shrewd enough to see that the protection of India by land and sea cannot be secured by the Indian peoples, and that the protection of a just Government, notwithstanding its levelling principles and its troublesome reforms, is worth the price that the country pays for it.

There is, however, one source of misunderstanding which public opinion at home can do much to correct. Foreigners as we are and must remain, there is no reason why we should, like the Romans, treat the natives as barbarians. A courtesy of manner is a quality which might win many converts to British rule, and it is in English schools that this lesson may best be taught to the future military and civil officers of the Queen. The fault does not lie wholly with what I hear misnamed Anglo-Indian society. It was long ago remarked that the Englishman is an island rather than an islander, bleak, rough, and inaccessible. You must not depreciate the constant jar to the nerves of your countrymen which the worries and irritations of tropical life, the flattery of well-intentioned visitors, the pride and even insolence of caste, and the manners and customs of the East entail. Allowance must be made for human nature, and the sense of superiority which is at once the pride and the bane of a ruling race. A carping Press not merely assails the British official, but it compares our honoured institutions and measures to the worst types of Asiatic extortion. For all this allowances must be made, and the stories I sometimes hear in England of gross insult to Indian gentlemen may be disbelieved or regarded as exceptional lapses. But there still remain an exclusiveness and an occasional roughness of manner which are detrimental to the interests of India, and which are felt especially by those Indians who have been received into English society, or are able to compare manners at home with manners in India. The removal of this source of unpopularity lies in the hands not only of the civil official, but of the British soldier and the British merchant, and I believe that there is a growing sense of our obligations in this respect.

I may conclude this paper with a few remarks upon a subject which is not of less importance than the moral and material progress of India. I refer to the

Religious Attitude of India.

The British Government has declared and followed a policy of complete religious neutrality, and the countenance which the State gives to missionary societies goes no further than religious toleration, and a welcome to all agencies alike which advance education and promote a higher morality. As a public servant I must adhere to that attitude, however deep may be my abiding sense of the mighty power for good which Christianity has exercised in Europe and might exert in India. But in a country where religion and social bonds are two threads inseparably interwoven in the same web, where social reform cannot be effected without religious change, and where the *pax Britannica* is constantly broken by the jarring strife of religious differences, the administrator is bound to watch with care the course of the great streams of faiths and beliefs which carry the population this or that way. Reverting to the plan which I have

adopted throughout of contrasting the state of affairs in the Roman empire with that of British India, I notice that three influences of Roman rule which prepared Europe for the adoption of a new faith are at work in India. The *pax Romana* rendered possible the travels of St. Paul, and protected the Apostle from the fury of intolerant persecution. It broke down the boundaries of rival races, and levelled barriers to the spread of Christianity. The *pax Britannica* has rendered it equally possible for earnest men to present to India their treasure of great price and the secret of our success as statesmen or lawgivers. The Romans again united the intellectual civilisation and language of the Greeks to the strength of their own law and their consummate powers of organisation. The strongest bond of union between men is a common speech; and a language which cannot be the vehicle of new thoughts is an insurmountable barrier to the spread of ideas. The language of our Bible, as for example, its one word—charity, reminds us of what we owe to the power of Greek expression. In India the political reformer and advocate of representative institutions knows that he cannot advance a step without dressing in Hindu letters English words. The translators of the Bible have met with similar difficulties, and the spread of English has been their only resource. In the third place there is an analogy between Rome and Great Britain not only in the extension of peace and an expressive language, but also in the spread of a universal law extending an equal protection to high and low caste, to Hindu and Mahomedan, to man and woman—in fact to all of God's creatures, and preparing society for the consideration of the rights of fellow creatures whom selfish ordinance had placed beyond the pale of almost human intercourse.

I may not in this paper have done full justice to the debt which Europe owes to Rome for its codes of law, but I am sensible of it, and in this one respect I cannot claim that we are doing more for India than the old empire did for our ancestors. But here the parallel between Rome and Great Britain is to some extent interrupted. In the failure of philosophy the subjects of Rome were not hopelessly baffled and disappointed. They were tempted to hear new things if haply the true God might be found. The unknown God was still sought after, although he was, in the words of Euripides, "hard to guess at." But in India a torpor of mind and a lack of interest has succeeded to the exposure of errors and superstitious beliefs. As Sir Charles Elliott lately observed, "Hindu philosophy was introspective and incurious, occupied in pantheism and the mortality of matter, so that when it fell into decay it left a state of apathy and quietism, and a tendency to relapse into atheism." I am not sure that this is not a passing stage. I am at least certain that many thoughtful Hindus are dissatisfied with the present condition of their religion, and that a spiritual interest is being slowly aroused, from which missionary workers derive encouragment. The satisfaction which Wordsworth saw in the mind of the Pagan suckled in a creed outworn is being more and more withdrawn from the educated classes of India. If the leaders of Indian society should one day wake up to a full knowledge of the truth and its freedom, and if through their influence there should filter down into the masses a widespread reformation, Great Britain will find herself face to face with a situation unlike anything which the world has as yet witnessed. Pitt more than a century ago saw foreign princes buying votes in the House of Commons. Yet the only effect which our imperial responsibilities have produced on Great Britain during the nineteenth century has been a slight reaction upon English ideas. What might be expected both here and in India if a new breath were breathed upon the dry bones of the East, and a living spirit infused into Asiatic society, if the opposition to our policy ceased, and enthusiasm and spiritual life awakened India to a new life? England might then feel that the virtue had not gone out from her in vain, and she might herself receive back from the East new thoughts and new lights upon old problems, whilst India, united by one hope and one aim, would advance along undreamt of paths. The invasion of the Roman Empire by the barbarians might then be repeated in the exodus of spiritual and moral forces from regenerated India. This is perhaps a dream, and all that it is at present safe for me to say is that under the influence of the conditions which I have mentioned there are signs of unrest and religious upheaval in India, which indicate a feeling after truth and a raising of the questions "What life is? what God is? what we are?"

I must, however, bring my remarks to a close. The responsibilities with which it has pleased Providence to entrust us in India are very grave; and the accomplishment of our mission depends mainly upon two conditions, a healthy, persistent, and not half-hearted,

interest and control exercised by public opinion here, and the efficiency as well as the sufficiency of the small British regiment which directs the Indian administration under Her Majesty's viceroys and governors. No doubt all power and authority rest in the last resort on the sword, but it is for the most part a sheathed sword. India cannot defend herself by sea or land, and we must be prepared to draw the sword on her behalf. She has not yet learned the whole duty of man to man or even religious tolerance, and we must, by force if necessary, preserve the internal peace. But our victories must mainly be those of peace, and since the problems of Indian administration are so complex, public opinion here must be pronounced with full knowledge and patient deliberation, and our agents in India must be the best men you can send forth. There are many intelligent Indians who are watching with grave concern the apparent depreciation of the Indian Civil Service as the competition falls off with the rupee. But at all cost the Indian vineyard must find good honest workmen, imbued with Christian purpose and high political aims. Our nation is indispensable to the divided peoples of India as its defenders, as the only possible cement to its social and religious ranks, as impartial administrators of law and justice, and as the messengers of a higher and more progressive civilisation. It is an idle dream to expect popularity in India, and the men who do their duty to you and to the country in which they serve will be spattered with newspaper abuse. We want, therefore, strong men, as well as earnest and patient men. The problems of Indian administration become every day more tangled, and the actual work more heavy as the population increases, and as the Indian races acquire new desires and new aspirations—

> "For men begin to pass their nature's bound
> And find new hopes and cares which fast supplant
> Their proper joys and griefs: they grow too great
> For narrow creeds of right and wrong, which fade
> Before the unmeasured thirst for good."

These lines of Browning point in my opinion to the most striking contrast between Rome's and Great Britain's ideas of empire. Terse but sufficient was the Latin expression *vici*; for, with the Imperium which followed her conquests, and with the maintenance of the Roman peace, Rome felt that her task was accomplished. The material profits of victory were thenceforward the Roman's right. The British ruler has a wider vision of new hopes and cares, of a future federation of mankind, of a laborious straining after a higher moral and social life, of the progressive growth of the different societies and communities which owe a common allegiance to the Queen Empress—a growth which must be suited to their environments and capabilities — and above all of an account which this country must one day render to the giver of all victory. The conquest was not completed on the fields of Indian battles. Nay, it only begins when the sword is sheathed; and in the struggle with wrong and selfishness which then ensues, the forces of your Indian officials need constant reinforcement and encouragement from the centre of our national life, a sound public opinion in England, whence the virtue of British empire may go forth to the uttermost parts of the Queen's dominions.

DISCUSSION.

Sir George Birdwood, K.C.I.E., C.S.I., in opening the discussion, said he did not feel at all equal to offering an adequate, or in any sense serious appreciation of the scholarly, deeply interesting, and eloquent address to which every one present must have listened with unqualified pleasure and admiration. He, indeed, did not altogether approve of the practice that had been growing into great popularity in the Indian Section of the Society of Arts, and with which they were apparently beginning to infect the Imperial Institute, of raising haphazard discussions on the papers so carefully prepared for them by writers who were invariably recognised authorities on the subjects dealt with by them at the Society's special invitation. But Mr. Lee-Warner would understand that the criticism invited on these occasions was, after all, but intended to be supplementary to that enlargement of information and maturement of judgment on the resources and interests of the Empire which they all sought to derive from the papers read before them; and Mr. Lee-Warner would quite understand that any remarks which he (Sir George Birdwood) might venture to make on his able and exceptionally instructive address were simply in the perfunctory discharge of the duty laid on him as chairman of the Section to open the discussion. He might, therefore, frankly say that while assenting to all that Mr. Lee-Warner had advanced as to the absolute excellence—that was the purity, the humanity, and what was really of more moment in the present connection, the ability—of the administration of British India, and unreservedly supporting all Mr. Lee-Warner had said with so much weight of experience and force of conviction, and all he had implied, beyond what he said, of the grave necessity for the supreme control of the Imperial Parliament over the Government of India being ever exercised

with not less scrupulous circumspection and discretion than vigilance; while agreeing to all this, he could not acquiesce to the dark colours in which Mr. Lee-Warner had—by way of contrast, he presumed—painted the corruption and the vices of the administration of the Roman Empire. At least Rome endured 500 years after she had subdued the world, or for 1,200 years from the date assigned by tradition to the foundation of "the Eternal City;" and it would be time enough when the British Empire had lasted as long to vaunt the superior virtues and wisdom of its Indian administration. The truth was, he did not see how, in a question of this sort, the consideration of relative corruption and vice was of any pertinence. What made and maintained empires was capacity, and what wasted and destroyed them was incapacity. Rome was not ruined by her corruptions and vices; nor by her besetting economic evils—the *latifundia*, the concentration of the rural population in the towns, the State workshops, with their slave labour, the *annona*, and other forms of State socialism, the worst of all being the admission of the unemployed into the army; and certainly Rome was not ruined by the inexorable severity of her rule. To this, indeed, she owed its prolonged endurance; and to this, moreover, they owed the transmission to modern times of that Hellenic culture and Roman law which were, throughout Europe and America, the essential and specific characteristics of Western civilisation. Christianity itself was under lasting obligation to Rome. She moulded alien nations into one brotherhood, and breathed into them the quickening spirit of humanity, and this new spirit prepared the way for the teachings of the Gospels, the rapid spread of which was due to the unity given to the Old World, concentered round the Mediterranean by the Roman Empire. It was true that Rome persecuted the early Christians, but not for their Christianity, but because they were incorporated as a Church militant. The paganism of Greece and Rome was even less organised than that of the Hindus, who had for its sure bulwark their remarkable social system of caste; and the Greeks and Romans were as sympathetic with the simple evangelical teachings of Christianity as were the Hindus; and what the Romans objected to was exactly what the Hindus resented—the aggressive propagation of Christianity by ignorant, uncultivated, and indiscreet missionaries; and what the Roman Empire objected to was, the refusal of the Christian recruits to take the customary oath of allegiance on joining the eagles, and the ever-growing portent of the elaborately-organised Christian Church as a state within the state, or *imperium in imperio*, which at last, under Constantine the Great, virtually became the Empire. Civilisation, in short, owed everything to Rome; to that Roman Empire evolved out of Republican incapacity and chaos and methodised by Julius Cæsar on so enduring a basis of reason and law that to this hour it had not been overcome, except in its external political forms. They met there that day in reality as citizens of Rome—of the wonderful Roman world created by the genius and the power of Julius Cæsar—and they had come there from the very streets of London, the "Old City" of the recent Unification Report, and along the high roads leading therefrom, first surveyed and laid down by Julius Cæsar and his successors 2,000 years ago. If 2,000 years hence people in India were making a similar observation on the reign of the Queen-Empress Victoria, it would be quite time enough for us to indulge our self-complacency. The truth was that Rome was destroyed simply by incapacity; the incapacity shewn in her case by the neglect to provide for the legal transmission of the imperial power. Something like a regular succession was kept in the Julian House by the prestige of its founder, and the nominal choice of the Senate. But the new mercenary army soon claimed its share in the election. For a time the Autonines were able to check its usurpation, but with the assassination of Commodus the prætorians had it all their own way again; and the confusion and violence accompanying every dislocation of administration on the constantly recurring demise of the purple, became almost continuous, and through a long protracted decline brought the Roman Empire to an end. Diocletian and Constantine indeed succeeded in breaking the power of the army, and giving due preponderance to the civil administration of the Empire, but it was too late, and also inopportune for already the barbarians were pressing on the frontiers, and the status, prestige, and efficiency of the army were lowered at the very moment when its assistance was most needed. As to the cruelty of Rome, it had assuredly been greatly exaggerated. If Galgacus ever uttered that epigram quoted by Mr. Lee-Warner it only showed that the irrepressible Celts were allowed to be as rhetorical under Roman as under British rule. But he never uttered it. It was invented by Tacitus, and with a purpose—the greater glory of his father-in-law, Agricola. It was in Egypt, perhaps, that the Roman and British administration might be best compared. The Romans had there to deal with hostile tribes on long extended frontiers, with Greek colonists who despised the natives of the country, and, in the large cities, with those turbulent populations of Jews, who might be said to represent the Mohammadans in India. Yet all the time of the Roman rule in Egypt the country would appear to have been kept in order by a few cohorts of German cavalry. Of course there were the three legions in Judæa and Phœnicia (there were eight, altogether, between the Orontes and the Tigris and Euphrates), which could be relied on in an emergency, and which were called in once or twice to quell the Jews; and if we could now govern Egypt as quietly and economically as this it would certainly add a feather to our cap. He must, indeed, confess to serious surprise at Mr. Lee-Warner's apparent depreciation of the Roman administration. Hitherto an almost slavish appreciation of Roman

rule has been a marked characteristic of the British governing classes. Some years ago entering a railway carriage he found in it two young ladies puzzling over the relative positions of Naples, Brindisi, and Venice; when, after discussing the question for some time, one of them appealed to a young gentleman sitting opposite, who turned out to be her brother:—"Charlie, you are in the 6th Form at Eton, and should know." Turning from the *Sporting Times*, in which he had been absorbed, he replied, with authority:—"Naples I know, and Brindisi I know, but of Venice I know nothing; it must have been one of those barbarian places beyond the limits of Augustus." His ignorance of modern geography was reprehensible, but his answer showed him to be possessed of that pride in Rome, and in Roman ideals, which had always been the strength of British statesmanship, and would always remain the surest pledge of its success. He could add a great deal more, and much more acceptably to himself, on the parallelisms in minor matters between the Roman and the British administrations; as in the matter of the appointment and induction of governors in which the closeness of the parallelism was almost amusing; and again, between the lives of the Roman officials in the Provinces and of English officials in India, in which its touching closeness draws our hearts out to the Romans as brothers indeed, and our same selves. But he had already occupied too much of the time at their disposal there that evening. He would have liked, also, to have enlarged on the topic of our popularity and unpopularity in India, but time pressed, and he would only remind them, with reference to the comparative disparagement of Rome in which Mr. Lee-Warner had indulged, that our official purity—although we must insist on it—does not necessarily make us more popular in India, or stronger. Public corruption never yet destroyed an empire, nor public purity saved one. In certain stages of civilisation, or rather of popular culture, corruption had proved a salutary element of national health and vigour. He remembered a voter at the last election remarking:—"I never care to vote, now that it does not mean business (*i.e.* payment for his vote), and the old country may go to the devil, for me." Juvenal tells us the same thing in his "Xth Satire":—"Ever since our votes were no longer for sale to the highest bidder, the sovereign people have ceased to interest themselves in the public weal; and they who once appointed commanders and governors, and gave away legions, now care only for their daily doles of bread, and the games of the circus." The Asiatic ideal of a just judge was still he who took a fee, or bribe, as we call it, from both parties to a suit, and returned it to the party non-suited. Some thirty years ago, a wealthy Hindu merchant, the subject of a native State, comparing a recently appointed official of the State with his predecessor, observed to me, quite naturally, in odium of the former:—"He's good enough, but the *divine being* who preceded him would always take the customary gift into his own *divine hands*, while with the present man it gets no further than his (as we would say) usher, and I never feel sure of my business receiving due consideration." What we stigmatise as a "bribe," seldom in the East means anything more than what we well know as a "refresher." Again, one of the greatest of modern native administrators once told him that the habit of taking what we call bribes was so instinctive in him, by hereditary transmission, that he never gave audience to a complainant, or applicant of any sort, but he felt his right hand involuntarily twitching to receive the traditionary douceur. Ever since he knew this, his heart had bled for the natives in our service in India, so completely do their ideas on these points differ from our platitudinous professions, and so miserably was their personal honour thus placed in momentary and irremediable jeopardy at the hands of inconsiderate, and it might be Pharisaical European colleagues and superiors. He always had in mind in connection with their pathetic predicament the quaint simile applied by Sir Munguldas Nathoobhay to himself, as standing between the antagonistic schools of "Old" and "Young" Bombay:—"Miserable wretch that I am, I feel like the big drum in a band, kicked at both ends." It would be the Chairman's duty to move the vote of thanks to Mr. Lee-Warner, but before sitting down he could not help adding, as chairman of the Indian Section, his sense of the deep obligation under which that gentleman had laid them by the brilliant paper with which he had so kindly, and, it was to be feared, at considerable inconvenience to himself, favoured them. It was a paper at once of marked literary excellence, and the greatest practical merit, and full of facts and suggestions of abiding interest and value, and it would, he was sure, be always gratefully remembered by every-one of them who had been privileged to listen to it there, surrounded by the appropriate associations of the Imperial Institute.

The Lord Chancellor said he was sure they had all listened with the greatest interest to the paper. No doubt the Roman rule had left many great and important traces behind it. Nobody could look with anything but admiration upon the marvellous system of law for which we were indebted to the Romans. But the comparison between the Roman administration and our own lay rather in the object aimed at in the administration of the countries conquered or subdued. The object of Rome was to maintain peace and order for the good of the peoples under her rule, and not merely her own advantage; and it could hardly be questioned that the idea now animating Englishmen was to exercise the power we now possess in India, not for gain to ourselves, but to develop in that country a higher condition of peace and prosperity than would exist there without us. That was the end we had in view. The system of Roman law was magnificent,

but the finest system must be comparatively worthless without a pure and righteous administration. In that respect our rule contrasted favourably with the rule of Rome. We had done our best to give to India a system of law suited to her needs, departing no more than was necessary from her own systems, and constituting an outgrowth from or grafting upon them rather than setting them aside. Nothing was more remarkable in our administration of India than the extent to which this had been accomplished through the natives themselves. We had not sought to administer the law there simply at the hands of men who had gone from this country for the purpose. One of our great aims had been to train the Indian people to administer the law for themselves, and to ensure that justice should thus be done as reliably as by Englishmen. The figures given by Mr. Lee-Warner showed the extent to which that result had been attained. Nothing was more astonishing than that the great variety of races, creeds—people often of bitterly hostile views—should have been governed by an insignificant number of Englishmen; but we had enlisted in the administration the services of the natives, so that, in truth, it might now be said the administration in India was largely carried out by her own people themselves. He believed that if the time should ever come when the people of this country were convinced that thay might leave the whole administration of India in the hands of the natives—though that might seem a far-off dream at present—the law would be as well enforced and the country as well administered as by our own Government, or that of any other self-governing country. We gained nothing in the way of personal advantage from our administration of India; and an India well-administered and well-governed would be as acceptable to the people of this country as the India of to-day. We should, under those circumstances, be content to leave it to them, in the belief that we had fulfilled our mission—with the glory of having accomplished a greater work than had ever been fulfilled before. There was no desire on our part to exploit India for any selfish advantage to ourselves, or for purposes of our own. That, however, was as yet a far-off dream. It should be remembered that the failures in our administration of the country had resulted from its very success, for the people could now pass throughout India from end to end and pursue their avocations in peace; the roads were as safe as in England. The natives had become so accustomed to the new order of things that the memory of far different conditions had vanished, with the result that those to whom the change was due got none of the credit for it, and it had ultimately come to be thought that British rule might be dispensed with. Our very success, therefore, had added to our difficulties; but, even if it were the case, as had been said, that the different races in India, who were formerly hostile to each other, would be prepared to join hands in opposition to us, that, again, was only a testimony to the success of our rule, in having brought men into peaceful and friendly contact with each other to an extent which was not the case before, although, no doubt, the smouldering fires of race or creed animosity were not yet extinguished. With all our progress in India, we must not be too impatient. We should remember that it is a country of many peoples of different races, creeds, and prejudices; and we should not try too hurriedly to force our Western ideas upon natives of the East. We ought to recognise that their sensitiveness may be as great as our own, and that in substituting a higher for a lower state of civilisation, we may, by seeking to go too fast, defeat the ultimate object we have in view, and make our progress slower instead of more rapid. The worst thing that could possibly happen to India would be to be governed by unenlightened men, regardless of the conditions of life among her peoples, and led by notions that what was good for ourselves must necessarily be good for them. That would be the doom of our rule in India; it was a danger, and the only real danger facing us. A tendency altogether was seen at the present day, in Englishmen, more than in former times, to say what ought to be done in India. Let us avoid such folly as that. A healthy public opinion should be at the back of the Indian administration, which should, at the same time, be carefully watched and guided by it. He regretted having detained the meeting so long, but to any one so interested in the affairs of India as himself, it was difficult to confine one's observations upon so attractive a subject within a very brief compass.

Sir Raymond West, K.C.I.E., said the subject before the meeting was important, not only to those interested in India, but to all who were concerned for the welfare of our own country. He had often, in his experience in India, been led to institute comparisons between our own legislation and administration there, and the Roman system and Roman law; and he had been much struck at the light thrown by the one upon the other. Our Mahometan predecessors in India probably derived their landed system, in part at least, from their contact with the Romans in Syria and Egypt, whose system they had made part of their own, as it now existed in Mahometan countries with regard to the ownership of land, its relationship to the *res republica*, *i.e.*, the body of the faithful, and the rights appertaining to it. He would not dwell further upon that interesting subject. The paper naturally induced the question—"What had Rome to teach or suggest to us in the administration of our great dependency with a population greater, probably, than that of Rome at its widest extent?" In the Roman rule, one constant source of mischief existed in the complete subordination of the judicial to the administrative system. A second element was the absolute subordination of the civil to the military power. There was room for improvement in our rule in India, and advantage might be gained from a consideration of the mischief which had resulted to the Roman Empire from

those causes. Anyone of unbiassed mind acquainted with India, would say that the greatest acknowledged blessing of our English rule was the purity of the judicial administration, and its independence of its executive. Yet a greater benefit would arise when a more complete division was made between the ministerial and the magisterial administration, and some means ought to be, and could, he thought, be found of benefiting the country by a further distribution of powers between the executive and judicial functionaries. The subordination of the civil to the military powers, and the intolerable burdens placed upon the provincials for the sake of the army under the Roman system, would lead to a long discussion, and he would, therefore, do no more than call attention to it. It was a subject worth the notice of anyone seeking to derive advantage from drawing parallels of this kind. Another source of mischief in the Roman Empire was the want of knowledge of a science the application of which would, he trusted, keep our Indian Empire in a healthy condition longer than the former had been able to maintain its prosperity. As far as could be judged, the Romans were absolutely ignorant of the laws of political economy. To them that was a sealed book, and the neglect of even its primary principles was the greatest source of weakness in their rule. For instance, they paid their army in coins which were forced upon the provincials at a much larger nominal value. Again, money was issued by the emperors of one-third, a fifth, even a tenth of the value at which the provincials were forced to receive it; and the revenue was then collected from the provincials, not in money as issued by the emperors, but in money of intrinsic value, so that if a man was assessed at one solidus, he might have to pay 10 or 20 of the depreciated currency. That was, of course, fatal to industrial enterprise, for no man could know what he might have to pay, and it was a sore mischief which continued from generation to generation. Another cause of mischief was the turning over of one non-paying proprietor's tribute on his holding to others. All these things operated as constant sources of weakness; and during the latter period of the Roman Empire, the people were so harassed by the perpetual increase in their taxation that, in a number of provinces, they received the barbarians with open arms, and it became necessary to prevent them flying over the frontier to the barbarians to escape the impositions laid upon them. Municipal or city life being crushed out by merciless oppression, the rural populations had no example to go by, and patriotism was extinguished. It was to be hoped that nothing of the kind would take place in India. Our efforts should be directed to encouraging growth of civic life among her citizens. One branch of the Roman system we might imitate with advantage, in constituting local councils, which should be responsible for the welfare of the cities. A good deal might be done in India by expanding the municipal systems in the way of forming the chief inhabitants into committees, answerable for good order in the towns where they now enjoyed so many privileges and advantages.

Mr. M. M. BHOWNAGGREE, C.I.E., had heard the paper with great satisfaction. From his own experience, he could testify to the correctness of the analogy drawn between the administration under the Roman Empire and that of the British rulers of India. It was impossible at that hour to go at any length into the various points dealt with by Mr. Lee-Warner so elaborately and learnedly, but he was gratified to see that most of the conclusions in the paper were conceived in the broadest spirit, and the lecturer had well expressed his opinion, from 25 years' experience of the country, that no hurry should be made to interfere with the administration of native States by their chiefs. He had heard with great interest the sentiments enunciated in reference to the treatment of the Indian peoples. Their rulers should endeavour in every way to win their confidence in discharge of the duties incumbent upon them. The people of India were grateful for any courtesy shown them by British administrators, to whose courtesy and geniality of demeanour, on the whole, he could testify. From the standpoint of the natives of India, the paper deserved the best attention of its rulers; and it dealt with certain prominent features of Indian affairs in a way which the younger generation of British Indian officers would do well to lay to heart.

The CHAIRMAN, in the name of the meeting, conveyed to Mr. Lee-Warner their hearty thanks for his able, excellent, and interesting paper. Our ignorance of the condition of Indian peoples had been referred to, but he thought very few Anglo-Indians were fully aware of the density of the ignorance of English people on the subject. He trusted, therefore, Mr. Lee-Warner would take some other means, if possible, beyond reading his valuable paper at this meeting, to impart knowledge on the subject to his fellow-countrymen at home.

The meeting then terminated.

FOURTH ORDINARY MEETING.

Wednesday, December 12, 1894; Professor THOMAS EDWARD THORPE, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Copus, George, Halstead, Essex.
Barth, Frederick Alfred, 47, King-square, E.C.
Gammell, Hector Hatch, Birnbech-house, Weston-super-Mare.
Hales, William, 29, Birdhurst-rise, Croydon.
Holmes, William, 18, Cicada-road, Wandsworth-common, S.W.

Parry, William Kaye, M.A., 35, Dame-street, Dublin, and 6, Charlemont-terrace, Kingston.
Smith, T. Walrond, 137, Victoria-street, S.W.
Willis, John, Stansfield, Clewer, Windsor.
Woodward, Edward Francis, 43, Southwell-street, Bristol.

The following candidates were balloted for and duly elected members of the Society:—

Brocklehurst, George William, Rock-house, Sydenham-hill, S.E.
Elmes, Sidney W., 62, Sydney-street, South Kensington, S.W.
Fox, Francis Douglas, M.A., 28, Victoria-street, Westminster, S.W., and Coombe-springs, Kingston-on-Thames, Surrey.
Fulton-Smith, James, 14, Museum-street, Warrington.
Jeckell, Joseph Alexander, South Shields.
Parnacott, Alfred, The Ferns, Penge, S.E.
Switzer, Sidney A., 28, Queen-street, Horncastle, Lincolnshire.
Thomson, George, Woodhouse-hill, Huddersfield.
Unwin, Philip Ibotson, Lordswood-lodge, Harborne, Birmingham.
Wethered, Thomas Arthur, Marlow, Bucks, and Grand Hotel, Puerto Arotava, Teneriffe.
Winby, Frederick Charles, 47, Portland-place, W., and 11, Clement's-lane, E.C.

The paper read was—

THE MANUFACTURE OF SALT.

By Thomas Ward.

Salt, in one form or another, is perhaps the most widely spread of all minerals. It is a constituent of all sea water, and there are few brooks or rivers that have no traces of it. Salt lakes abound in many districts of the earth, and saline springs are very widely distributed. Salt appears also in the solid or mineral state in beds of rock salt in most of the geological formations, with perhaps the exception of the very earliest. Not only is salt thus widely distributed, but it is also equally widely used, being a necessity of life.

The object of this paper is to deal with the various methods by which salt is manufactured or produced in different parts of the world, but more especially in England.

Brine is the foundation of the salt manufacture, and it will be necessary to define what is meant by it. Brine is water holding salt in various proportions in solution. By salt in this paper is meant chloride of sodium (NaCl). Brine exists naturally in the sea, in salt lakes, and in some rivers and springs. It is formed also by water coming into contact with mineral salt. Fresh water will take up more or less salt, according to its temperature, varying from 35½ lbs. at freezing point (32° Fahr.), to 40 lbs. at boiling point (226° Fahr.), for every 100 lbs. of water. Saturated brine at 60° Fahr. contains 26½ per cent. of salt. Brine is rarely fully saturated, so it is customary to speak of a good brine as 1 part salt, 3 parts water. This, for practical purposes, is sufficient to remember. In England, especially in Cheshire, the salinometer is graduated in ounces of salt per gallon of brine. The old wine gallon of 231 cubic inches, and not the imperial gallon of 277·274 cubic inches, is the one referred to, and a fully saturated brine is described as a 2 lbs. 10 oz. brine. It is a curious fact that the specific gravity of saturated brine is to that of water in exactly the proportion of the imperial gallon to the old wine gallon, or 1·2 to 1.

Natural brines are scarcely ever fully saturated. The water of the sea varies very considerably, containing about 1½ per cent. of sodium choloride in the Black Sea; 2½ per cent. in the North Sea; 2½ to 2¾ per cent. in the Atlantic; and nearly 3 per cent. in the Mediterranean. Where the sea is an open one the salt content rarely exceeds 3 per cent., and varies very little from top to bottom. In salt lakes we meet with brine from less than 1 per cent., as in the Caspian Sea, to more than 10 per cent. of chloride of sodium (to say nothing of the other salts) in the Dead Sea. There are numerous salt lakes on the steppes of Russia; as also in Central Asia, and many other parts of the world. The salt content of these lakes varies according to the season of the year. In the rainy season the brine is weak; in the dry season saturated. There are in deserts and dry districts where salt abounds salty brooks and streams, as the Looni in Rajpootana in India, and the brooks running into Lake Elton in the Russian steppes. Natural salt springs, like the seas and salt lakes, are rarely saturated, many being merely brackish; but there are a few where the water contains considerable quantities of salt, as in Cheshire and the Luneberg Heath in Hanover, and when this is the case it indicates the existence of beds of rock salt in the neighbourhood. In some parts of the world salt marshes abound, and what are called in America "salt licks," which are of a similar nature. From the sea, salt lakes, salt springs, and salt marshes, salt has been at all times obtained, and is so still.

It was a long time before men attempted to find stronger brine than that of the springs

flowing away at the surface near brooks and streams. In searching for other minerals, chiefly coal, rock salt has occasionally been discovered, and frequently accompanying it strong brine, often fully saturated. It was not till the year 1670 that rock salt was discovered in England, near Northwich, when prospecting for coal. Brine was found on this rock salt, and was described as more "sharp and vigorous" than that found in the springs rising to the surface, which had been used for making salt from the time of the Romans, or earlier. In Canada rock salt was found at a depth of over 1,000 feet in boring for petroleum.

In Germany bore-holes have been put down where brine springs of a weak nature existed, and, in the majority of cases, rock salt and strong brine have been discovered. In the United States, within the last few years, many bore-holes have been put down, in some cases to the depth of 2,500 feet, and rock salt discovered, but no natural brine. The same has been the case at Fleetwood and Middlesborough in England. In all these places water has been put down the bore-holes, or permitted to enter from the water-bearing strata passed through, and allowed to saturate irself on the salt, and is then pumped up. This system of obtaining brine has been used in Germany and the East of France for many years. Rock salt, being very easily soluble, the water quickly becomes saturated. The plan usually followed is to have a double pipe or tube, that is, a small pipe or tube within another rather larger. The larger tube is usually five inches in diameter, the smaller about 3½ inches in both England and America. The ring, or space between the two pipes, is used to put the water down, whilst the internal pipe serves as a pump up which the brine rises. A column of 120 feet of water balances one of 100 feet of saturated brine. Occasionally, in America, the water is forced down at a pressure of 160 lbs. or so to the square inch, which pressure forces the brine up the inner pipe to the surface, and no pump is needed.

At Tully, in New York State, some 15 miles or so from Syracuse (one of the oldest salt manufacturing districts in the United States, and where only weak brine existed), a bed of rock salt has been discovered at a spot some 400 feet above the level of the salt works at Syracuse. About 400 feet higher still, and further up the valley, several lakes exist. The water of these lakes is conveyed by pipes to the beds of rock salt at Tully, which are some 1,800 feet below the surface, and the head of water is sufficient to lift the brine to the reservoirs on the surface, whence it flows by gravitation to the alkali works at Syracuse. The system of making bore-holes and allowing water to get to the salt, has extended very rapidly.

In the Northwich salt districts in Cheshire, there are a large number of abandoned rock salt mines. Fresh water has broken into these, and saturating itself from the rock salt, has formed enormous underground reservoirs containing a practically inexhaustible supply of strong brine.

The brines formed immediately on or in the rock salt are nearly or quite saturated, and therefore much stronger than the natural brines found in seas, lakes, and springs. In the Carrickfergus district in Ireland, where there is no brine on the rock salt, and where no water is put down bore-holes, the rock salt is mined and put into reservoirs, and the water added to it.

Rock salt has been used to strengthen weak brines, or to mix with, and strengthen sea water, for a considerable time. There are salt works along the coasts of Ireland and Scotland at the present time, where the brine is formed in this way; and in Belgium, Holland, and Denmark, large quantities of rock salt are imported for dissolving and making brine, which is then used in the manufacture of white salt.

Brine is present in all parts of the earth, and of all degrees of strength up to saturation point. Until it reaches this latter point however, no salt will form; hence it is evident that such a thing as a salt deposit at the bottom of the sea is impossible, sea-water containing, on the average, only 3 per cent. of salt. When it is said that the huge beds of rock salt, met with in so many places, were deposited at the bottom of the sea, it is evident that the statement is incorrect, or else that the sea water must have been a saturated brine. This, however, could not be; for animal and vegetable life cannot exist in a fully saturated brine. When brine is of full strength a state of equilibrium is reached, and any decrease in the quantity of water or increase in the quantity of salt, destroys this equilibrium, and a portion of salt is deposited. The water once saturated will take up no more salt, and it is a common saying in the salt districts, that the safest way to keep rock salt from dissolving is to put it into saturated brine.

Salt, in brine, is not held in suspension, but in solution. Hence, however long the brine is

allowed to remain, say in a closed vessel, no salt will deposit. The business of the salt manufacturer is to remove the water, when the salt will crystallise out and form a deposit. During the whole time of the removal of the water the salt deposits in such quantiry as to keep the brine just saturated. The best, and almost only way, to get rid of the water is by evaporation.

The problem to be solved in the manufacture of salt is to so regulate the evaporation that the kind of salt required is produced. The great factors in evaporation are heat and dryness. A moist heat is almost useless, hence, in tropical countries where there is great moisture, little or no salt can be made. A dry wind, without much heat, causes rapid evaporation, and in Germany, where the natural brines are very weak, huge thorn hedges are built up in the line of the prevailing dry winds, and the weak brine is allowed to trickle amongst the thorns so exposed, and a large portion of the water is evaporated. The brine caught at the bottom in troughs is in this way much strengthened. This graduating of the brine, as it is called, is frequently resorted to.

In rock salt mines, where the air is dry, and neither sun nor wind can penetrate, evaporation takes place, and when brine has flooded the sole or floor of the mine, as has happened occasionally, the water, in process of time, becomes evaporated, and splendid crystals of rock salt are left behind.

There is another way in which salt is sometimes produced in intensely cold regions, viz., by making shallow reservoirs, and allowing the watery portion of the brine to freeze, and the salt to deposit. A short time since a patent was submitted to me for artificially freezing brine, and thus obtaining salt. The great drawback to any such system of salt-making is, that there will always be three tons of ice produced for every ton of salt made. Besides this, it would not be possible to manufacture the different qualities of salt required. Practically, the evaporation in making salt is caused by heat, and the water evaporated dissipates itself in the atmosphere in the form of steam or vapour and requires no further attention.

The heat used in salt-making is either natural or artificial. Natural heat is that of the sun. All salt made by the heat of the sun is technically known as solar salt. Solar heat is the cheapest obtainable; but it has its drawbacks. The greatest of these is that it cannot be regulated, consequently it is not possible to make the various grades of salt required, which all need different degrees of heat properly regulated. Another drawback is that the heat is not continuous. After the sun is set the evaporation is very slow, and the time required to make salt is much lengthened, and in the rainy season or winter no salt can be made. Again, if the air is very moist or rain falls, not only is there no evaporation, but a good deal of the work previously done is undone. Part of the water evaporated returns, and to restore the brine to saturation some of the salt already made is dissolved, the water saturating itself at the expense of the crystals already formed. At Syracuse, in New York State, and also in Michigan, men are constantly on the look-out to run wooden covers over the pans in which solar salt is making, as soon as any sign of rain appears. Solar salt-making can only be carried on successfully where the summers are hot, and at the same time fairly dry. It has often happened that a spell of wet weather has set in before the salt harvest has been gathered, and has blighted the prospects of the salt-makers. Where, as along the shores of the Mediterranean, and along the Atlantic shores of Spain, Portugal, and France, the seasons are regular, and fine weather is tolerably sure, mnch solar salt is made. The shores of the Red Sea and Indian Ocean are in many places suitable for solar salt making. The numerous salt lakes on the Russian steppes produce immense quantities of solar salt, as also does Lake Sambhur in Central India. In the Dead Sea and along the eastern shores of the Caspian Sea, where there are both heat and dryness, salt is deposited very largely, and huge beds of rock salt are being formed. From these modern deposits the method of formation of rock salt in past geologic ages can be easily determined.

In places where solar heat cannot be relied on in the manufacture of salt, or where qualities of salt are required that the heat of the sun will not produce, artificial heat is used. In early days we are told that the brine was sprinkled over burning wood, and the salt collected from the ashes. Wood has at all times been used as a fuel for obtaining the heat for evaporating brine. In England, until comparatively recent times, it was almost exclusively used. In a letter of February, 1605, it is said that the wood consumed annually in making salt was, at Nantwich, of the value of £1,728; at Middlewich,

£1,435 4s.; at Northwich, £2,056 10s.; or as the letter says, "Spent in the wich houses yearly in wood £5,219 14s." Wich-house was the name for the house in which the pans were kept for boiling the salt. The word is still frequently used at Northwich for the pan-house. The pans at this period were called "leads," being made of lead. Wood is still used on the Continent, where coal is scarce, for boiling the brine, and it is used either by itself or in conjunction with coal, in Canada for the same purpose. In the lumber districts of Michigan, the refuse wood and sawdust from the saw mills are used under the boilers to generate the heat for the steam required in making salt.

Slack, or small coal, is almost exclusively used in England, and most parts of the world; being more plentiful and much cheaper than wood. The average price of this fuel at the salt works in England is from 5s. to 6s. per ton. In England, direct heat is chiefly used; that is, the fires are made underneath the pans or vessels containing the brine. In America and Canada the heat is first used to generate steam in large boilers. This steam is conveyed in pipes to the pans in which the salt is made, and the pipes pass through the brine, communicating their heat, and causing evaporation. The chief business of the salt manufacturer is to utilise to the best purpose, for the production of salt, the heat obtained from the fuel. To this end, innumerable patents have been taken out, but few have been so successful as the simple application of direct heat to open pans. The method seems a very primitive one, and most visitors to salt works think they can improve upon what they consider a cude, antiquated system. I have had brought before me, and have seen working, scores of patented plans. In all, or nearly all, the idea was to economise heat; and if the whole of salt manufacturing consisted in evaporating the greatest quantity of water with the least quantity of fuel, doubtless many of the schemes would succeed instead of fail, as they do now. The majority of the plans are schemes for generating steam and using the heat, but occasionally (as just recently) gas under pressure, mixed with air, is lighted under a small kind of diving-bell, and all the heat thus generated is communicated to the brine in which the heater is immersed. Perhaps the most successful method of utilising heat is by what is called the vacuum process. In this, again, steam is generated in a boiler, and used to cause evaporation in a closed vessel. Thus, roughly speaking, salt manufacturers employ either direct heat from the furnaces, or steam generated in a boiler and conveyed through pipes.

Before describing more at large the methods used for producing the various kinds of salt, it may be well to recall the composition of brine.

In sea water, and the water of salt lakes and of most brine springs, the proportion of salt is comparatively small, and that of water very large. Hence, before any salt can be made, the water must be reduced so as to leave the proportion of 76 water to 24 salt; or, as before stated, 3 parts water to 1 part salt. To evaporate this water requires a great amount of heat, and it will at once be seen that if the heat obtainable is small, it must be applied for a long time. In artificial brines, or such natural ones as are found on beds of rock salt, the proportion of water to salt is usually 3 to 1 to commence with; so that it does not take long before there is sufficient evaporation to cause the salt to form or crystallise out of the brine. Brine boils at 226° Fahr., but it is not necessary to heat it to this point before evaporation commences and salt forms. The whole business of salt making consists, as was said before, in using the proper amount of heat to produce the kind of salt wanted. The greater the heat, the more rapid the evaporation, and the finer the grain of the salt. The lesser the heat the slower the evaporation, and the coarser the grain of the salt. The fine or boiled salt is taken frequently out of the pan, the coarse less frequently, according to the degree of coarseness wanted.

With varying exceptions, adapted to suit different localities, the method used in making solar salt on the sea-shore is to allow a quantity of sea water to run into a reservoir or pit, at the top of the tide. From this reservoir the brine is conducted to a series of shallow pits or pans, having a considerable area but little depth; the object being to expose as great a surface as possible to the heat of the sun. The shallowness allows the brine to soon become heated, and evaporation to commence. There is a series of these shallow pans or basins, and the brine, as it becomes stronger by the evaporation of the water, is passed on from one to another, till in the last, being fully saturated, the salt begins to form.

As the heat of the sun obtainable is small compared with fire heat, the process of evapo-

ration is slow, and the salt formed coarse in the grain. This salt is "harvested" at considerable intervals, and only during the hot dry season. At Syracuse, in New York State, and at Zilwaukie on the Saginaw river, in Michigan, solar salt is made from the brine of the districts. In Syracuse, where the brine is weak, it is first run upon a "flat" or wooden floor with a slight rim round it, only allowing a layer of very shallow brine to lie upon it. When strengthened, this brine is passed to a series of shallow wooden pans about 18 feet by 16, and 4 to 5 inches deep, of which there are many thousands constantly in use. The salt is taken out or "harvested," as it is called, twice in the year.

The salt obtained from the Salt Lakes on the Russian steppes, and from Lake Sambhur in India, as well as from other salt lakes in various parts of the world, is only got in the dry hot season. At this season of the year, the lakes shrink very much in area, and the salt forms in the shallow pools left behind by the receding lake, and in the shallow portions of the lake itself. The salt is taken from the bottom of the pools, or shallow portions of the lake, and stacked on the shores. Lake Sambhur in the wet season is from 15 to 20 miles in length; but in the dry season not more than from 3 to 4 miles.

One of the most interesting deposits of solar salt is that in the Kara Boghaz Gulf on the east coast of the Caspian Sea. This large gulf, covering an area of more than 2,000 square miles (German), is connected with the Caspian Sea by a narrow entrance about 150 yards wide and 5 feet deep. There is a bar at the mouth of this entrance over which there is a constant flow of Caspian Sea water at the rate of 3 miles per hour, containing slightly less than 1 per cent. of salt. So great is the evaporation over this extensive body of water that it is estimated by the best authorities that at least 350,000 tons of salt are being deposited daily, and an enormous bed of rock salt is being formed on the bottom of the gulf. This is one of the most instructive salt deposits in the world, and shows how by continuous evaporation, even so weak a brine as 1 per cent. can be made to deposit its salt.

The vessels, if they may be so described, in which solar salt is made are natural basins, such as lagoons and salt lakes, or ponds and pits made along the sea shores. The earliest artificial vessels used in evaporating brine were very small. As the demand for salt increased, the size of the vessel increased in a corresponding ratio, till now pans of enormous size are in daily use. The first pans of which we have any record in this country were made of lead, and were very small. There are two in the Salt Museum at Northwich, which were discovered a few years ago. The smallest is, roughly, 2 feet 1 inch square by 3 inches deep, and holds about 7 gallons. The other is 3 feet 8 inches by 2 feet 8 inches, and 4 inches deep, holding about 20 gallons. This latter pan is about the size used in the 16th century, and six of these leads, as they were called, were included in each wich-house. In Hall's "History of Nantwich," p. 203, we have the following interesting description:—"The ancient way of makeing salt with us, was in lead pans, whereof every wich-house had six of equal gage: and in those they boyled their salt with wood cloven and fitted for ye purpose. This was ye way and usage of makeing salt in this towne till the VIth yeare of King Charles I. (1632). And then it was, that some fancifull persons thought it would be more for their profit to boil their salt in iron pannes (of equall gage with the six leads) with pitte coale, pretending that wood grew scarce."

Thus, at the time that iron was substituted for lead, coal took the place of wood. In 1659 we find a great dispute caused by the substitution of two "great pans," instead of the previous four or six. In 1675, it would seem the large pans were in general use, as in a report made in that year it is said, "Eache wich-house hath two *ovens*, a *ship*, a *chamber*, or *store*, and two *iron pannes*." By a "ship" is meant a long wooden trough, generally a tree trunk hewn out, to contain a store of brine.

Shortly after the proper way of using iron for the making of salt pans was found out, the size of the pans began to increase rapidly. In 1748 Dr. Brownrigg, in his book on "The Art of Making Common Salt," says, "the length of some of these pans is 15 feet, the breadth 12 feet, and the depth 16 inches." In a note he adds, "at many works they use pans of a much less size than here described. But those used at Shields and other places near Newcastle are much larger, being commonly 21 feet long, 12 feet and a half broad, and 14 inches deep, being the largest salt pans used anywhere in Great Britain." According to a small pamphlet published at Leipsic, in 1776, by a German named Chrysel, who had been in England experimenting at the salt works, the largest pans in the country then were two at Northwich, being respectively

36 feet by 25 feet and 13 inches deep, and 40 feet by 27 feet and 13 inches deep, and one giant at Winsford 52 feet by 26 feet and 13 inches deep. The average pan at that time is described as 24 feet by 15 feet and 12 inches deep. At the same time Chrysel speaks of the German salt pan being 8 feet square by 9 inches deep. Little by little the size of the pan grew, more especially the length of it; the width being determined chiefly by the length of the raker, the man taking or drawing the salt out of the pan could comfortably use. From 1694 to 1823, salt paid a heavy duty, so that the manufacture did not grow so rapidly as after 1823, when the duty was repealed. During the great French war this duty was as high as £30 per ton.

The pans used at the present day are very large. Those actually working in Cheshire and Worcestershire range from 30 feet by 24 feet and 15 inches deep (this being about the smallest now used except in a few of the oldest works, where pans about the size of those in use a century ago still remain) to 130 feet by 25 feet, and about 18 inches in depth. The usual size for pans that are required to boil is from 30 feet to 40 feet in length, and from 20 feet to 27 feet in breadth. For pans making coarse salts the usual size is from 60 feet to 70 feet in length by the usnal 25 feet to 26 feet in width, though at many of the modern works these pans are from 70 feet to 130 feet in length, and up to as much as 30 feet or, in one or two cases, 32 feet in breadth. The most approved width is about 26 feet. There is no absolute rule for size of pans. There are pans, under which exhaust steam is used, as much as 150 feet in length. Should it be found necessary to use a long pan for boiling purposes it is "mid-feathered" off, as it is called; that is, a portion is divided off by a wooden partition making a "front pan" for boiling and a "back pan" for coarse salt.

The pans spoken of so far are all open pans, and the heat is given to them by fires underneath. Besides these open pans there are a number of circular enclosed pans, known technically as "patent butter-pans," from the kind of salt made in them. This salt is the finest made in England. The pans are from about 21 feet to 27 feet in diameter, and are completely covered in. The fires are made under these pans as under the open ones, and the waste heat from the fires and steam from the pans are conveyed under other open pans, where coarse salt is made; or else the waste heat is carried in flues to the stove where the salt made in lumps, or squares as they are called, is dried.

The growth of the pans from the one holding seven gallons, or the average one of 20 gallons, to that in use now containing 30,000 gallons is comparable to the growth of the trade. In 1675 the three Cheshire "wyches" are stated to have produced 20,000 tons of salt annually. In 1875, when the large pans were in extensive use, the same district produced about 1,750,000 tons.

The pans in use in America differ very considerably, with few exceptions, from those in use in this country. In Syracuse, New York State, and Zilwaukie, in Michigan, "covers" are used when solar salt is made. In Syracuse, Warsaw, Saltville in Virginia, and at a few small works in other parts of the country "kettles" are used. These are very similar in appearance to the ordinary washing boiler found in cottages in this country. These kettles are set in a double row, sometimes to the number of 100, and the flues go underneath. In several cases, instead of the kettles being set directly over the flues, they are set in what are called "jackets," and steam is forced into this "jacket" or steam chamber. The pans, however, in most common use, are called "grainers." These are made of wood, the general size being about 120 feet by 11 feet, and 22 inches deep, though some are as long as 190 feet. Lying near the bottom of these grainers are iron pipes, about four inches in diameter, which pass up and down the pans, and through which live steam is passed. In the lumber districts, however, the exhaust steam from the saw-mill boilers is used to heat the brine. In the St. Clair district, Michigan, and the Kansas salt districts, iron pans—similar to those in England—are being generally adopted. At St. Clair a circular pan—similar to the patent butter-pan in use in England—was being worked four years ago. At Silver Springs, in New York State, and, more recently, at Cayuga, in the same State, and also at several places in Michigan, vacuum pans are being used. These pans are the most successful patent pans now being worked. They consist, generally, of a cylindrical vessel, containing a set of pipes. The brine to be evaporated is either contained in the pipes, and the chamber heated by steam, or the chamber contains the brine, and the pipes the steam, which is used direct from the boiler. As fast as the steam produced by evaporation rises, it is carried away by a

powerful air-pump, and a vacuum kept. Evaporation is by this means rapid, and the salt forms very quickly. It is proposed to use the steam thus drawn off to heat another similar vessel, and in some cases a third. The vacuum pan has its advantages, but brine is difficult to deal with, and the pipes get coated with sulphate of lime and rendered almost inoperative.

In many places it is customary to heat the brine before passing it into the evaporating pans. Most frequently this is done by waste or exhaust steam, or the pipes through which the cold brine passes are carried at the back of the fires or along the flues. Occasionally the brine heaters are placed at the back of the pan, and between it and the chimney, so as to still further utilise the heat.

In England the pans are made of either iron or steel plates, rivetted together. The usual thickness of the plate is $\frac{1}{4}$ in. for steel, and $\frac{3}{8}$ths for iron, with $\frac{1}{2}$ in. or $\frac{5}{8}$ths for the rims. The sizes of plates vary very much, from about 3 feet to 8 feet in length, and from 1 foot to 4 feet in breadth. The pans are heated by fires made under them. These vary from 2 to 4 according to the width of the pan. The usual number is 3 for 24 feet, though many 25 and 26 feet pans have 4 fires. The fire-grate is about 5 feet in length, and has fire-bars from 4 feet to 4 feet 6 inches, and a dead-plate, as it is called, in front of them. The distance of the fire-bars from the pan bottom is usually from $2\frac{1}{2}$ to 3 feet, though in special cases more. The heat from the fires passes under the pan along flues to the chimney.

There are many systems of arranging these flues, but the object in all cases is to economise heat by making all possible use of it under the pan, and not letting it escape too soon up the chimney. It is impossible to utilise all the heat, for the draught up the chimney, which is necessary to make the fires burn briskly enough to sufficiently heat the brine, carries much heat with it.

In the case of the short pans, where the brine is required to boil so that salt suitable to form the squares or lump salt of commerce may be made, the surplus heat, not used in making salt, is passed through flues and utilised in the stove or drying-room at the rear of the pan.

It is not necessary to enter into all the details of construction of the pans or the hurdles upon which the salt is placed when taken out of the pans, or the pan houses, or other common arrangements; it will be more interesting to describe how the numerous salts of commerce are produced and fitted for the purposes for which they are used.

From what has been previously said, it will have been seen that the whole process consists in the right manipulation of the heat employed. To produce very fine salts, the brine must boil, which it does at 226° Fahr. The coarsest salt does not require more than about 90° Fahr., and between these ranges the various kinds of salt are produced.

The grades of salt manufactured in this country may be classed under the heads of either (*a*) fine salt or (*b*) coarse salt. The fine salts are such as require the brine to boil, and are technically known as butter salts and stoved salts. The butter salt is divided into patent butter, fine butter, and coarse butter. The stoved salts are usually known as handed squares, and factory filled squares or lumps. There is no difference in the quality of the salt in butter and stoved salt. Both kinds are boiled salts, but the butter salt is drawn out of the pan in bulk and allowed to drain, then taken into a storehouse and stored in bulk. The stoved salt is drawn out and placed in moulds or tubs, as they are called, then, after draining, it is turned out of the tubs and carried into a hothouse or stove to be thoroughly dried. The coarse salts are known as common salt and fishery salt, and there are varying grades of both. Common is chiefly known as either fine common or coarse common. Fishery salt is usually classed as second fishery, best fishery, or best Scotch and extra fishery, described as either X or XX. There is a kind of salt coarser still, known as bay salt. These classes include really all the salts of commerce. There are special grades made for special purposes, or to meet special fashions, that have particular names given to them, such as cheese salt, brisk salt, middle grain, marine, Boston common, light Lagos, special coarse, besides numerous brands of factory filled salts, having particular names, as well as many kinds of table salt, sold under all sorts of names and descriptions.

The pans are worked by men known as firemen and wallers. The men drawing the salt into moulds very often combine both the fireman and the waller in themselves, and are generally known as lumpmen and salt boilers. The business of the fireman is to "put the salt into the pan," as it is termed. He is indeed the real maker of the salt, and it is his business to attend to the fires and see that the

proper degree of heat is maintained to produce the salt required. He has a damper placed in the flue near the chimney to regulate the heat. The regulation of the heat is almost entirely a "rule of thumb" question. It is very rare indeed that a thermometer is used. The technical knowledge acquired enables the man to see at a glance whether the pan is working properly; and the quantity and quality of the salt produced show whether he has done his duty. Besides attending to the fires, it is part of the fireman's duty to "rake off," as it is called, that is, to rake the salt back that falls over the fires, so as to prevent the plates burning. In some cases he has to rake the salt from the middle of the pan to the sides. He has also to see that the pan is kept properly supplied with brine, which is usually allowed to flow gently into the pans during the making of the salt. The whole of the brine is never evaporated, or the salt would be difficult to draw out, and would often be completely discoloured and spoiled.

The man whose duty it is to draw the salt out of the pan is called a waller, from an old Saxon name meaning a boiler. In early times, when the pans or leads were small, one man boiled the salt and drew it out of the pan. When pans increased in size the waller got an assistant to help in the firing, and to wheel the ashes away. Now, in many cases, the fireman and the waller are entirely distinct. The fireman having put a proper quantity of salt into the pan the waller proceeds to lift, or draw the salt out, using a peculiar bent perforated shovel called a skimmer. His only other tool is a raker, either with a long or short handle to bring the salt near enough to the side of the pan to be lifted out. As the brine is not all evaporated, the salt in being lifted through it is washed, and much of the brine runs back into the pan through the perforations in the skimmer. All salts, except such as are put into moulds to be stoved, are thrown on a flat floor or hurdle, sometimes raised as high as the rim of the pan so as to allow the brine draining from the salt to run back into the pan. Where however brine is plentiful, the hurdle is level with the "standing side" or place where the waller stands to draw the salt. After the salt has remained some hours on the hurdles, for the bulk of the brine to drain out of it, the waller fills it into carts and wheels it to the storehouse. The quantity of salt drawn out of a pan depends upon the size of the pan and the length of time the salt remains in the pan, and varies from five to eight tons per day in the case of handed squares or factory filled squares. Where pans are drawn once a day the quantity of salt varies from seven to ten tons or more. Where every two days these quantities are doubled. Fishery pans, drawn every 7, 10, or 14 days, usually have from 25 to 35 tons of salt in them.

The brine from which the salt is made in Cheshire and Worcestershire, is found just overlying beds of rock salt. It is simply the ordinary spring or well water of the district that has come into contact with the salt beds, and has thus become nearly or quite saturated with salt. A shaft or well is sunk to this brine, and it is pumped up and conveyed to large reservoirs either made in the earth, or made of wood. From these reservoirs the brine runs through iron pipes (though perforated tree trunks were formerly used) to the pans.

The brine as pumped from the earth is generally as perfectly clear as the purest spring water. When thus pumped up, it may however be either weak; that is not fully saturated or may contain impurities. Brine is rarely if ever a solution of pure chloride of sodium and water; and often requires a certain amount of treatment either before or during the manufacture. When the brine is merely weak it is a simple question as to the cost of the fuel necessary to evaporate the water, whether it will pay to make salt out of it or not. The chief impurities in solution are sulphate of lime, chloride of calcium, and chloride of magnesium. There are, at times, impurities in suspension, such as marl, or clay, but these can be allowed to settle in settling tanks or be filtered out. Occasionally a gelatinous mixture chiefly jelly from calves feet, made into a broth, is used. This is put into the brine, and as the brine heats a scum forms on the top which is taken off. The impurities in solution are more difficult to deal with. The sulphate of lime deposits at a less heat than the chloride of sodium, and forms a scale on the bottom of the pans. A portion of salt deposits on the lime, and the whole forms a hard crust of salt and sulphate of lime, known as pan scale. Over the fires, where the salt that falls is continually raked back, only a very thin lime scale forms, which is very hard and almost insoluble in water. Every brine contains more or less of sulphate of lime. It is this sulphate of lime that interferes so materially with the vacuum pan process, and many other patented pro-

cesses that might otherwise succeed. It is necessary, where the lime is in excess, to scale or pick the pans very frequently. Boiling pans scale much more freely than the pans used in making coarse salts, and require letting out at intervals of two or three weeks to be scaled or "picked" as it is called.

The chlorides of calcium and magnesium are only present in small, almost inappreciable, quantities, in English brines; but in the American brines, especially in the older salt districts, they are present to a serious extent. Where these chlorides are in excess, the salt very readily imbibes moisture, and, at the same time, it is nearly useless for curing purposes.

It is usual to treat the American brines with quicklime in the reservoirs, and this is allowed to gradually settle, so that some time must elapse before the brine can be used. Hence numerous small tanks or reservoirs are required. Where kettles are used, flat sheets of iron are suspended in them, and as the brine heats the objectionable ingredients to a considerable extent, deposit on these plates, which are then removed. Where, as in pans or grainers, this cannot be done, the salt is often washed in a solution of saturated brine and soda, which removes the chlorides. Brine is very easily affected by various ingredients, and small quantities of soap, glue, resin, and similar things are used for various purposes difficult to explain. This is called, technically, "poisoning" the brine. The grain of the salt is chiefly affected by these things. A small fragment of butter will change the working of a pan, and a very small quantity of several very simple, but very mischievous, materials will entirely alter the working of the brine, and change the quality of the salt. It is the knowledge of these various apparently trifling things that distinguishes the old saltmaker from the novice; and the lack of this knowledge that renders so many patents useless.

The natural salt crystal, when heat is used to evaporate, and the crystals form on the surface of the brine, as is usually the case, is in the shape of a hollow, inverted pyramid, technically known as a "hopper." This hopper only forms when coarse salts are being made, and the surface of the brine is quite still. The hoppers float on the surface and keep increasing in size and thickness until they will no longer float, they then sink to the bottom of the pan, and if allowed to remain become solid and lose their regular shape by others falling on them and forming an irregular mass. In boiled salts the crystals which first appear on the surface of the brine are broken by the motion caused by boiling and do not form hoppers visible to the eye, but sink quickly to the bottom as minute flakes or grains.

The crystal of rock salt is a perfect cube, with a line of cleavage parallel with each face of the cube. This crystal is of very slow growth, and forms at the bottom of the brine when the evaporation is very slight. Rock salt crystals are semi-transparent.

The following will give an idea of the processes pursued in salt making:—

Patent Butter Salt.—This salt has the finest grain of any salt manufactured. The pan used is circular, and covered over, and the brine is kept boiling. There are sets of rakers kept moving by machinery, so that the salt, owing to the constant motion of the brine' does not crystallise except in very small grains, and these are carried by the rakers into the pocket at the side. There are two sets of men employed at these pans, as they are constantly at work, and the salt is removed twice every twelve hours.

Fine and Coarse Butter.—These qualities of salt are made in open boiling pans, and the fine butter approaches very near in grain to the patent butter, but is only taken once in 12 hours out of the pan. The pans used for butter salt are shorter than those used for the coarser salts. There is a gradual merging of butter salts into common salts, so much so, that it is difficult to tell whether to call some qualities coarse butter salts or fine common salts. The coarse butter salts do not require the brine to be kept constantly boiling.

Common Salt.—This salt, which is the next in coarseness to butter salt, is made at various temperatures, but generally from 170° Fahr. to 190° Fahr. Common salt, called in some districts Broad, is the most cheaply made of any salt. The pans are very long, and there is a greater utilisation of the heat under them than under any of the pans where the brine is boiled, and, consequently, more salt is made per ton of fuel consumed. It is usual to consider two tons of common salt made for each ton of fuel used as satisfactory. This is about the average, though it varies with the quality of the fuel. As much as $2\frac{1}{4}$ tons of salt per ton of fuel is at times produced. It must be understood that saturated brine is used, or these results could not

be obtained. Common salt is the salt used at the alkali and other chemical works; also at soap works, glass works, and a variety of other works. It is used also, under the name of broad salt or agricultural salt, for land. (Sometimes by agricultural salt is understood refuse or soiled salt of any kind.) Common salt is taken out of the pan every 24 hours, if it is required to be fine, but only once in two days for the ordinary or coarser kind, and every three days for the special coarse.

Fishery Salt.—This salt—which obtains its name because of its extensive use for curing fish—is a coarse, solid-grained salt. Fishery salt approaches most nearly to solar salt. The degree of heat necessary to produce this salt is less than that required for common salt, and the salt is allowed to remain longer in the pan, so that the salt crystal can grow and "feed," as it is called. Some brines are more favourable for making fishery salt than others, though it seems difficult to say why this is so. The chemical composition of the different brines is so similar that only by practice can it be known which brines are most suitable for any particular class of salt. A few pounds of alum put into a pan of brine cause the crystals of salt to form of a harder and more solid kind. For what is called second fishery, which is the most extensively used, the salt remains in the pan seven days. This is the usual time, though with a few brines four or five days will suffice, whilst with others ten days will scarcely be enough. Best fishery, or best Scotch fishery, as it is called, is coarser and solider in the grain, and remains 14 or more days in the pan. When the salt has been so long in the pan a portion of it near the fires is much coarser than the rest, and this forms the extra fishery or X. and XX.

Bay Salt, of which very little is specially made, is the coarsest salt manufactured. Before any brine is put into the pan thorns are laid all over the bottom of the middle portion of the pan, and strings are stretched across from side to side, a few inches apart; the brine is then put into the pan, and the fires made hot enough to nearly boil the brine. As soon as this point is reached, the fires are raked out, and the brine allowed to quickly cool down. In this process of quick cooling, the crystals of salt form in cubes all over the strings and thorns. Brine, when nearly boiling, will contain more salt than when cold, so that the sudden cooling causes the salt to rapidly crystallise out. When the crystals have "set" on the thorns and strings, small fires are put again under the pans and kept up continuously for about a month. The salt is then drawn out and the crystals taken from the thorns and strings. Besides these there are crystals on the sides of the pans. After draining, the large crystals are picked out by hand and the remainder of the salt is passed through riddles, and the coarse crystals all put into a warm room to dry or be stoved. It is a very pretty sight to see a pan with the strings and thorns all covered with crystals. In making bay salt and best fishery salt there is always a considerable quantity of inferior grained salt, especially at the back end of the pan, caused by the flaky, small-grained salt formed on the surface being carried back by the circulation of the brine from over the fires to the back, or cooler end, of the pan.

Handed Squares Stoved, or lump salt, such as is carried about in hawkers' carts for sale, and is used largely for household purposes, is the same quality as fine butter salt. The name butter was given to the salt because of its extensive use in butter-making. Instead of the waller drawing out the salt in a large heap on the hurdles, he puts it into tubs which stand inside the pan generally on a little platform at the side. These tubs are of various sizes, and are known by the number of lumps that make a ton of salt. The most common sizes for home use are one hundred and sixties, one hundred and twenties, and one hundreds. The larger size, or eighties, are generally shipped coastwise. The waller proceeds to fill the tubs that he has placed inside his pan, and, as he fills them and the bulk of the brine has drained out, he lifts them out upon the hurdle to still further drain. After an hour or so the lumps are turned out of the tubs, and, being "happed," or patted, into proper shape, are carried into the hothouse where they are allowed to remain till thoroughly dried through. The temperature of the stove varies very much, but is generally about 130° to 140° Fahr. When a lump is thoroughly dried it will "ring" when struck. Unles a lump is thoroughly dried, it will break or go soft when in transit in the boats or vans. It is necessary that the squares or lumps made for sale should be of fine salt, as the finer the salt the harder its sets and the less easily is it broken. Only about one and a half tons of squares are made per ton of fuel used, much

heat being required in the stove to dry the salt.

Factory Filled Stoved Lumps.—In some trades it is necessary to have stoved salt, but squares or lumps would be very inconvenient. When this is so the lumps, after drying in the stove, are taken to a mill and broken and filled into sacks or bags. For the finer qualities of salt sieves are used in connection with the mill, and all degrees of fineness, from ordinary butter salt to superfine table salt, are produced. The trade in what is called packet salt is extending. Instead of the large lumps, which are apt to get dirty and soft, small calico bags, holding 12 lbs., 7 lbs., 5 lbs., and 3 lbs., are much used, especially in America. In England, jars, bottles, drums, and paper packets are much used, and the penny packet, or even halfpenny packet is coming into vogue. The salt in all these packages is a stoved salt, which has been milled and sieved. In America there is a general absence of stoves or drying-rooms, and no moulds are used. The general use of grainers and steam, lead to the production of what is known as common fine salt, a kind of coarse butter salt. As practically all the heat in the steam is used in making salt, none is left for stoves. To meet this difficulty what are called "Hersey Driers" are used. These are iron cylinders, similar to an ordinary land boiler, of some 30 to 36 feet in length. They are set at an angle over a furnace, or have a jacket for steam. The salt, after being drawn from the pan and allowed to drain, is passed into the upper end of the drier, and as this latter revolves the salt passes slowly over the heated surface till it reaches the lower end of the drier, where it is discharged perfectly dry and very hot. If a finer grade of salt is wanted it is passed through small mills, and thence conveyed to the packing-rooms, where it is filled by girls or young women into the various packages before described, and usually these are stowed in barrels, which in America take the place of sacks in this country.

It would take too long to describe the trade in salt at home and abroad. The magnitude of it can, however, be conceived when the last Government return for 1893 gives the following figures for the United Kingdom:—Rock salt, 192,960 tons; salt from brine, 1,731,069 tons, or a total of 1,924,029 tons. The year 1893 was less than 1892 by some 34,000 tons.

The salt districts of England where white salt from brine is produced are Cheshire, where in 1893 1,213,362 tons were produced; Worcestershire, which produced 192,021 tons; Middlesborough district, 289,198 tons; Fleetwood, 37,488 tons. In Cheshire the trade has been carried on from the earliest times, and is now connected with Winsford, Northwich, Middlewich, and Sandbach. In Worcestershire the manufacture has existed for centuries, at Droitwich, but of late Stoke Prior has produced most. Middlesborough and Fleetwood have only commenced to make salt within the last ten years.

Much more might be said about the salt manufacture did time permit, but it would not be right to conclude without referring to the results following the pumping of brine.

As before mentioned, brine is formed in the salt districts by the ordinary spring or well water coming into contact with the beds of salt. The moment the water reaches the salt it proceeds to dissolve it, and continues to do so until it has taken up sufficient to form a liquid containing 26 per cent. of salt. As fast as this liquid is pumped up, fresh water takes its place, and so the process of solution is continuous. The result is that the surface of the salt is eaten away in deep furrows or miniature valleys, and the earths lying above follow the contour of the water-worn salt, making similar valleys and subsiding areas on the surface of the land. Where these sinking area are in towns much destruction is wrought amongst the buildings, sewers, gas and water pipes, streets, roads, and other property. In the neighbourhood of brooks or rivers the subsiding areas soon become pools of water, and finally large lakes, continually increasing. In districts such as Northwich, where there are numerous worked-out salt mines, the subsidence is more serious, and enormous mischief is done. The salt districts of Cheshire are extremely interesting, showing the action of water on beds of salt on a gigantic scale, and demonstrating how changes of the earth's surface can be made by a very simple means. The question of subsidence, so interesting in itself, is too extensive to be dealt further with at the end of a paper already too long, I am afraid.

DISCUSSION.

Mr. F. W. PRICE asked what was the effect of the salt-working upon the health of the men engaged in it?

The CHAIRMAN proposed that the best thanks of the meeting be given to Mr. Ward for his extremely interesting and most suggestive paper.

Mr. WARD, in acknowledging the vote of thanks, said with regard to the effect of the work on the operatives, the trade was extremely healthy. The men lived long, and seemed to enjoy their lives very much. Certainly it had not been perceived that their health was affected in the least, whether they were engaged down below or in the works above-ground, though they no doubt were in a damp atmosphere.

The meeting was then adjourned.

Chicago Exhibition, 1893.

FINANCIAL STATEMENT.

The following statement of accounts from 30th April to 6th December, 1894, is supplementary to the statement published in the Report of the Commission (*Journal*, vol. xlii., p. 591, May, 18th, 1894), and shows the disposal of the balance given in that statement and of sums since received :—

Dr.

	£ s. d.	£ s. d.
To Balance, as per published Statement of 30th April, 1894 :—		
In hands of Coutts and Co.	583 14 4	
In hands of Secretary (petty cash) .	31 4 4	
		614 18 8
Since received :—		
Johnstone, Norman, and Co. (on account of sale of Victoria House)...	500 0 0	
Repayments, salvage, and petty revenues ..	415 0 9	
		915 0 9
		£1,529 19 5

Cr.

	£ s. d.	£ s. d.
By Victoria House, Chicago :—		
Freight of returned goods		263 1 2
,, Fine Arts Section :—		
Freight	24 9 2	
Distribution	37 10 10	
		62 0 0
,, Women's Work Section :—		
Freight		21 11 6
,, Official exhibits :—		
Freight		234 7 3
,, Salaries and allowances		653 19 9
,, Printing		184 10 0
,, Petty cash charges (April to Nov.). .		95 9 9
,, Distribution of Medals		15 0 0
		£1,529 19 5

Examined with the Books and Vouchers, and found correct.

December 6th, 1894. J. O. CHADWICK & SON, *Chartered Accountants, Auditors.*

Miscellaneous.

THE EGYPTIAN SUGAR INDUSTRY.

The first practical step by the Egyptian Government towards inaugurating the sugar industry was in the year 1818, with the erection of a sugar manufactory at Reyremoun, in the province of Minieh, which district to day is the centre of the business. The plans and schemes upon which the factory was constructed were those in vogue at the time in the Antilles. As experience was gained, the industry grew to larger proportions, until Egyptian sugar was favourably known in the home markets. The United States Consul at Cairo says that, in 1826 European refined sugar—considered better in quality and lower in price—came upon the Egyptian market, and, for the moment, stifled the home trade. Domestic sugar was, however, restored to favour, and, in 1833, the factory of Reyremoun produced 29,000 cwts., and Egyptian sugar controlled the market in every town of Lower Egypt, from Cairo to the Mediterranean. Thus was established the sugar industry of the Nile country, and, as years passed, other factories were established. There appears, however, to have been no general movement in the direction of extensive production either in the reign of Mehemet Ali, or his successors, Ibrahim, Abbas, and Said. Practical impetus was given to this industry in 1875, when there were grown on the Khedive's Daria Sanieh estates 9,200 feddans (feddan = 1·03 acres) of cane; on other properties of the Khedival family about 500 feddans, and on private estates about 5,300 feddans. Much of the cane from the last mentioned estates, however, was used for *assul*, or molasses. To this should be added 9,000 feddans of cane sugar, consumed by the peasantry, as food, in a fresh state. These figures, from an authentic source, indicate that the product

of only about 15,000 feddans was made into sugar. The progress setting in, in 1875, has been steadily maintained until the present time, not only in area under cultivation, but in the per-centage of sugar obtained from the cane. The acreage on the Daria Sanieh estates in 1893 was nearly four times greater than in 1875, while on other Khedival estates the cultivation has ceased. On private estates it had increased to 12,000 feddans; and the area devoted to food for the peasantry, and not included in the above figures, was 12,000 feddans. Thus, the area devoted to the manufacture of sugar is now 49,000 feddans, against 15,000 feddans in 1875. Advancement is further demonstrated by an analysis of the statistics for the years 1875 and 1893. In the former year a feddan yielded 1·44 tons of marketable raw sugar, against 1·94 in 1893. This increase, resulting mainly from improved methods of extraction, is no less than 35 per cent. In the cultivation of the cane, planting takes place in March, after the land has been ploughed three times. On the important Government estates modern steam machinery is used, but the small native farmer still uses the wooden plough, known in the East from time immemorial. The seed cane, cut in lengths of about 35 inches, is set in furrows four feet apart and eight inches deep, with little or no space between the pieces. The furrows usually bear north and south, that the young plants may escape damage from prevailing winds. When the planting is completed, the soil is periodically watered from the Nile, until the crop is matured, about the end of December, when it is ready for harvesting. The cane is conveyed to the mill for crushing as soon as possible after cutting, to prevent fermentation. The yield per acre depends, of course, largely upon adaptability of soil, water supply, and care in the several processes of cultivation. The Daria Sanieh estates employ in cane growing about 6,000 men, with their families, and a daily wage of from 5d. to 10d. per person is paid. There have been many experiments with artificial manures; but while fertilizers have been found which increase the product, their cost has prevented their adoption. Superphosphate of guano gave excellent results, and cane compost very little benefit. Soil from the ancient towns and villages—costing nothing but the labour of gathering—is employed wherever possible, and with fair profit. Pigeon manure is used with benefit on some estates in Upper Egypt, where enormous numbers of pigeons are kept for the purpose. As on cotton lands, almost the only fertilizer used on the Egyptian sugar plantations is the Nile water, carrying a muddy deposit of magical richness. Cane crushing begins about the 1st of January, and continues for a hundred days or more. It furnishes employment at the Daria factories to 8,500 natives, at wages of from 7d. to 10d. a day. The cane is brought from the fields by trains of from 20 to 30 cars, running on agricultural railways. There are more than 300 of these lines. Seven years ago the Daria factories adopted the "double pressure" system, which largely explains the improvement in product shown by the statistics already quoted. After the cane has been crushed in the first mill, the mash is watered and conveyed to another, which completes the extraction process. The "megass," or cane fibre, is drawn away to the drying field by small locomotives, and furnishes three parts of the fuel for running the factories, an important item in a country having little wood, and no coal save that brought from abroad. There is in Egypt but one refinery, owned by an influential company, and situated on the Nile about 50 miles south of Cairo. It has a capacity of 15,000 tons per annum, but its output never exceeds 12,000. French processes are employed, and its sugars are claimed to be equal to the best in the world. Consul Penfield says, in conclusion, that while the conditions of irrigation remain as they are, the area under sugar cultivation cannot be materially extended, cane being a crop demanding much water at a time when the Nile is at its lowest point; but if the project for giving the country perennial irrigation, by the construction of a vast reservoir at Assouan, to husband the flood of the high Nile until the summer months, be successfully carried out, it is the general opinion that the cultivable limits of Upper and Middle Egypt may be doubled, as tens of thousands of acres would be brought within reach of the proposed high-level canalisation. The reservoir is said to be practically assured.

Correspondence.

EXPERIMENTS IN AERONAUTICS.

With reference to the question "How does a bird fly?" which I put to Mr. Maxim when giving us his most interesting paper on the above subject, I shall be glad if you will allow me to more fully explain my reasons for endeavouring to obtain information on this point.

I now gather that Mr. Maxim has no particular theory of flight from the fact of his omitting to explain any such theory. He merely replied that it would be as absurd to imitate the complex movements of a bird's wings, as it would be if, instead of using the locomotive up to date, we were to construct a machine to imitate the movements of a man's legs. All will agree with the idea conveyed by this remark of Mr. Maxim, whilst no one in his senses would think it of practical use to imitate mechanically the "exact" movements of either fish, flesh, or fowl, in water, on land, or in the air; as a matter of fact we do imitate the movement of the legs not "exactly," but "in principle," and we imitate it not "instead of" but "by means of" the locomotive.

The power of propulsion on land is obtained by the grip of the object on the earth with the foot in

one case, and the wheel in the other; the muscles in one case, and steam in the other, forcing another foot or a different part of the wheel forward until it has obtained a fresh grip, and so on, the only difference being, that in the mechanical appliance the grip is continuous, in nature it is intermittent.

It must, therefore, be admitted that on land the principle of propulsion, as permitted by nature, is followed and imitated by man mechanically by means of a rotary or continuous motion.

In the same way, in water, we know the propulsion permitted by nature in the form of a fish, is by means of its tail being made to push intermittently against the water, thus propelling the fish, which is so formed as to be capable of floating in the water, and we again follow and imitate nature in principle, by using the screw propeller with a rotary or continuous motion.

I maintain, therefore, that it is absurd to apply the screw propeller (however big the blade) to any endeavour to fly, as there is nothing in nature as represented by living animals having the power of flight, which, in any way, corresponds to the movement, or principle of the movement of the tail of a fish in the water.

Mr. Maxim has already been given credit for having solved the problem of flight, and he himself is reported to have said he has followed after nature, but has he? Certainly not, he apparently has not yet discovered the principle upon which nature permits propulsion through the air.

To solve the problem, the conditions upon which nature permits flight must first be discovered, and then let experiments be made imitating such part or motion of a bird as nature tells us is essential in dealing with the air, by the application of a mechanical substitute with a rotary or continuous motion properly adapted to the conditions of flight, when we know them.

Mr. Maxim's attempts to fly by means of screw propellers should be regarded in about the same light as he would doubtless regard any invention designed to screw itself over the surface of the earth. The screw propeller is the mechanical equivalent for nature's method of propulsion through water, and is no more adapted to the air than it is to the earth.

In closing this letter I wish to state emphatically that I am a firm believer in the possibility and probability of flight by mechanical means, and having studied for upwards of ten years the conditions upon which nature permits flight, I am absolutely convinced as to the correctness of the knowledge I have acquired, and as to the extreme simplicity of putting the theory into actual mechanical practice.

I am only waiting a favourable opportunity and sufficient funds to enable me to construct a machine to act upon the same principle as governs the flight of birds, and I may add that no other travelling will be so safe as by air when the conditions of flight are thoroughly understood.

GEORGE L. O. DAVIDSON.

LIQUID FUEL.

In the issue of 19th ult., under the above heading, Messrs. A. and C. Stewart allege that I made "slip-shod" statements in my condemnatory remarks, which they have done me the honour to repeat.

I would, however, with permission, point out that the statements I then made can most effectually be confirmed by Messrs. A. and C. Stewart themselves, inasmuch as they, as well as I, know that with the oil they used, costing a halfpenny per gallon (and which is not a commercial commodity—being blast-furnace oil, a bye product, and never being obtainable in appreciable and regular supply), they were only able to obtain a ratio in consumption of 1 lb. of oil to 2 lbs. of coal, and this as against a cost of about six shillings per ton for Scotch coal. In the face of this Messrs. A. and C. Stewart allege that it was only in consequence of the impossiblity to procure oil at a sufficiently low price, that the effectiveness of their invention was negatived.

EDWIN N. HENWOOD.

General Notes.

FRESCO PAINTING, &c.—The Italian Government have offered a prize of £120 sterling for the best essay on the *technique* of painting, frescoes, encaustic painting, distemper, and oil painting, with suggestions for the preservation of ancient painting. The essays may be written in English, and foreigners may compete. Manuscripts are to be delivered to the Minister of Public Education not later than the 30th June next. The essays will be adjudged by a special commission assisted by scientific experts.

AUSTRIAN MINERAL PRODUCTION.—The *Oesterreichische Zeitschift für Berg und Huttenwesen* gives an interesting statement of the mineral production of Austria for the year 1893, the figures being taken from the returns made to the Ministry of the Interior. The returns for the more important minerals are as follows:—Lignite, 16,815,955 tons; coal, 9,732,651 tons; iron ore, 1,109,112 tons; quicksilver ore, 76,215 tons; zinc ore, 30,531 tons; graphite, 23,807 tons; silver ore, 18,018 tons; and alum and vitriol shale, 13,370 tons. The output for the more important metals was as follows:—Pig iron (foundry), 555,062 tons; pig iron (forge), 108,283 tons; lead, 7,212 tons; zinc, 5,870 tons; sulphuric acid, 10,248 tons; and silver, 37,344 kilogrammes. It is stated that the output for most of the metals is of a steady nature. The increase in iron production is, however, considerable, and indicates a steady growth. The gold and silver output was almost entirely from Bohemia, as in former years. The quicksilver was chiefly from the famous mines of Idria, which supplied 87 per cent. of the total, the rest coming from St. Anna and Littai. The copper was from Bohemia,

Salzburg, and the Tyrol. Nickel, cobalt, arsenic, and chrome ore, have disappeared from the list of the products reported in former years, none of these minerals having been produced last year.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

DECEMBER 19. — "Forestry." By GENERAL J. MICHAEL, C.S.I. CLEMENTS MARKHAM, C.B., F.R.S., P.R.G.S., will preside.

Papers for meetings after Christmas :—

"The Separation of Aluminium by the Vautin Process." By PROFESSOR WILLIAM CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. CHARLETON, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. CROMPTON, M.I.E.E.

"Tea." By A. G. STANTON.

"Improvements in Milling Machinery." By J. HARRISON CARTER.

"Electric Lighting of Ecclesiastical Buildings." By MAJOR-GENERAL CHARLES E. WEBBER, C.B.

"The Lushais, and the Land they Live in." By CAPTAIN JOHN SHAKESPEAR.

"The Effects of Revenue Legislation on the Agriculture of the Madras Presidency." By C. KRISHNA MENON.

"The Projected Railways of India, and their Prospects." By J. W. PARRY, A.M.Inst.C.E.

"Drawing for Process Reproduction." By GLEESON WHITE.

"Technical Carpet Designing." By ALEXANDER MILLAR.

"The Art of Casting Bronze and Copper in Japan." By W. GOWLAND.

"Our Food Supply from Australasia." By E. MONTAGUE NELSON.

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

PROFESSOR VIVIAN B. LEWES, "Modern Developments in Explosives." Four Lectures.

LECTURE IV.—DECEMBER 17.—*Blasting Explosives.*—Requirements—Fiery mines—A good safety explosive as great a safeguard as the safety-lamp—Explosives employed—The safety explosives now in use—Roburite, &c.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered by PROFESSOR C. VERNON BOYS, F.R.S., on "Waves and Ripples," on Wednesday evenings, January 2 and 9, 1895, at 7 p.m.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "Modern Developments in Explosives." (Lecture IV.)

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. Bellyse Baildon, "The Papuan at Home: or a Visit to British New Guinea."

British Architects, 9, Conduit-street, W., 8 p.m. Professor Banister Fletcher, "The London Building Act, 1894."

Actuaries, Staples-inn-hall, Holborn, 7 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Edward Whymper, "Twenty-thousand feet above the Sea."

TUESDAY, DEC. 18...Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Statistical, Geological Museum, Jermyn-street, S.W., 4¾ p.m. Mr. Geoffrey Drage, "Alien Immigration."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Frederick Chapman. "Some Foraminifera obtained by the Royal Indian Marine Survey's SS. *Investigator* from the Arabian Sea near the Laccadive Islands." 2. Mr. P. R. Uhler, "Enumeration of the Hemiptera - Homoptera of the Island of St. Vincent, W.I." 3. Mr. T. D. A. Cockerell, "A New Species of the Family *Coccidæ* belonging to a Genus new to the Fauna of the Nearctic Region."

WEDNESDAY, DEC. 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. General J. Michael, "Forestry."

Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Mr. Robert H. Scott, "Report of the International Committee on the Cloud Atlas." 2. Mr. Henry Southall, "Rainfall and Floods in the catchment basins of the Severn, Wye, and Usk, November, 1894." 3. Mr. S. C. Knott, "Meteorological Observations at Mojanga, Madagascar, 1892-1894."

Geological, Burlington-house, W., 8 p.m. 1. Mr. Thomas Leighton, "The Lower Greensand above the Atherfield Clay of East Surrey." 2. Mr. W. S. Gresley, "The Eastern Limits of the Yorkshire and Derbyshire or Midland Coalfield." 3. Mr. W. S. Gresley, "Some Phases of the Structure and Peculiarities of the Iron Ores of the Lake Superior Region."

Microscopical, 20, Hanover-square, W., 8 p.m.

Inventors' Institute, 27, Chancery-lane, W.C., 4½ p.m. Annual Meeting.

THURSDAY, DEC. 20...Linnean, Burlington-house, W., 8 p.m. 1. Mr. H. M. Bernard, "The Spinning-glands in *Phrynus*." 2. Mr. Percy Groom, "Monocotyledonous *Saprophytes*.

Chemical, Burlington-house, W., 8 p.m. 1. Dr. N. Collie, "An Improved Form of Barometer." 2. Prof. Dunstan and Mr. H. Garnett, "The Chemical Constituents of Piper Ovatum." 3. Prof. Dunstan and Mr. H. Garnett, "Note on the Active Constituent of the Pellitory of Medicine." 4. Dr. W. H. Ince, "The Preparation of Adipic."

London Institution, Finsbury-circus, E.C., 6 p.m. Very Rev. Charles W. Stubbs, "The Ideal Woman of the Poets."

Historical, 20, Hanover-square, W., 8½ p.m.

Imperial Institute, South Kensington, S.W., 4½ p.m. "The Coal Fields and Mineral Resources of New South Wales."

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, DEC. 21...Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

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FRIDAY, DECEMBER 21, 1894.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 2 and 9, 1895, by Professor C. Vernon Boys, F.R.S., on "Waves and Ripples."

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. A few cards still remain, for which members should apply at once.

CANTOR LECTURES.

On Monday evening, 17th inst., Professor Vivian B. Lewes delivered the fourth and last lecture of his course on "Modern Developments in Explosives."

On the motion of the Chairman (Dr. William Anderson), F.R.S., a vote of thanks was passed to the lecturer for his valuable course of lectures.

The first lecture will be printed in the next number of the *Journal.*

APPLIED ART SECTION.

A meeting of the Committee was held on Tuesday, 18th December, at 4 p.m. Present: Major-General Sir John Donnelly, K.C.B., Chairman of Council, in the chair; T. Armstrong, Sir George Birdwood, K.C.I.E., C.S.I., Francis Cobb, Lewis F. Day, J. Hunter Donaldson, Sir Villiers Lister, K.C.M.G., G. C. S. Lock, T. Buxton Morrish, J. Hungerford Pollen, Hugh Stannus, F.R.I.B.A., with Sir Henry Trueman Wood, Secretary of the Society, and Henry B. Wheatley, Secretary of the Section.

Proceedings of the Society.

FIFTH ORDINARY MEETING.

Wednesday, December 19, 1894; Clements R. Markham, C.B., F.R.S., P.R.G.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Hedgman, W. James, The Firs, Upper Richmond-road, Putney, S.W.

Mayer, Daniel, 18, Great Marlborough-street, W.

Phillips, Charles George Washington, Grey Friars, Boston, Lincolnshire.

The following candidates were balloted for and duly elected members of the Society:—

Dawson, W. Bruce, 102, Tyrwhitt-road, St. John's, S.E.

Parry, Richard, 24, Great George-street, S.W.

Weekley, George Mitchell, Thornbury, Hornsey-lane, N.

The paper read was—

FORESTRY.

By General J. Michael, C.S.I.

Before entering on the subject of my present paper, I must ask indulgence from any scientific forester or botanist who, in hearing or reading it, may detect technical inaccuracies. I regret to say that I never had what could be called an education in the science of forestry, and I frankly confess that all I know of forestry has been picked up in an exclusively practical way, and is the outcome of the interest I have taken and the experience I have acquired in the subject during over fifty years.

As a boy, in Switzerland and Germany, forest operations had a great charm for me, and within four years of my joining the army in India, I was fortunate enough to be intrusted with the organisation of a tentative scheme of forest conservancy in the Southern Presidency, at which work I spent seven of the happiest and most profitable years of my life. From those days till I now have main-

tained an active interest in all that appertains to forestry, and while studying the practice and watching the progress of conservancy in all parts of the world, I have more and more become impressed with its importance. This must be my excuse for being here to-night, in dutiful and willing response to the invitation which the Council of the Society of Arts did me the honour, some months ago, of addressing to me. If my paper be wanting in technical and literary merit, it may at all events help to keep alive the interest in forestry which is, happily, becoming more and more widely felt at the present time, and perhaps other men, who are more capable than I am of dealing with the difficulties and hindrances which beset its higher development in the United Kingdom, may be led to come forward by the encouraging reception they are now sure to receive from the public, and thus help to place British forestry in a better position in the future than it has ever yet held in the past.

There is no doubt that within the last ten or fifteen years there has been a marked increase of interest in forestry, not only in England but also in our colonies and in America, and a sense of the importance of conservancy is growing up in every part of our vast empire. The International Forestry Exhibition at Edinburgh, in 1884, attracted great attention to the subject. People who had never given it much thought were not at all prepared to have so much interest almost forced on them by the extensive and attractive display of exhibits there made, illustrating forest products from all parts of the world, and the industries springing from and dependent on them.

In the same year, the Colonial and Indian Exhibition had also a comprehensive collection of forest exhibits, and it was a very satisfactory outcome of these two exhibitions that so many eminent men, well known to be conversant with the subject, gave an immense impetus to public thought and opinion in this country by writing and speaking of the great need of doing more in Great Britain and the colonies to promote a better care of woods and forests, and increasing their area. Never before has there been so much good writing and speaking on the subject as we have seen and heard during the last few years. I wish I could say that an equal amount of practical effort has followed—but that, we must hope, will come.

Many lectures and addresses have been delivered before this Society, the Colonial Institute, the Imperial Institute, and elsewhere, and still more numerous pamphlets and articles in magazines and the Press have appeared to stimulate public interest. I have only to mention such names as those of Somerville, Marshall Ward, Bayley Balfour, George Birdwood, Schlich, Pearson, and many others. Then, many valuable books and tracts have also lately been published on the subject. First let us instance the eminently scientific and practical "Manual of Forestry," now being brought out by Dr. Schlich, of Cooper's-hill College, and late Inspector-General of Forests in India. Two volumes of it have already been published and a third is shortly to follow. A sixth and greatly enlarged edition of "Brown's Forester" has lately been published, edited by Dr. Nisbet, late of the Indian Forest Department, and the author of "Studies in Forestry." Professor Somerville, of the Durham College of Science, has given us a translation of Hartig's "Diseases of Trees." Professor Marshall Ward has also a new edition of Laslett's book on "Timber and Timber Trees."

A valuable and scholarly report on the Spanish chestnut, by Sir George Birdwood, has again brought this tree into prominent notice. Although common enough in England it is hardly sufficiently appreciated, not only as a handsome adjunct to any plantation or wood, but as a very good timber tree for building, carpentry, and other purposes, while its branches and small wood are much esteemed for charcoal. Its wood, unlike the oak, is more valuable when young than old. It coppices well.

Botanists are greatly indebted to the Clarendon Press for the many foreign works of which they have published translations, and it is to be hoped that it may add to the botanical series some of the standard foreign forestry books. I should much like to see a translation brought out of a German book kindly lent to me by H.R.H. Prince Christian, Ranger of Windsor Park. It is entitled "Die Waldverderben und ihre Feinde,"—*Anglice*, Forest Pests and their Enemies, by the late Dr. Ratzeburg. A seventh edition of the work was published, a few years after his death, by his friend Dr. Judeich, the eminent director of the Forest School of Tharand, in Saxony. It treats not only of harmful beasts, birds, and insects, but also of those which, by preying on them, are really beneficial to forests, and ought therefore to be preserved. The book is both eminently scientific and pleasantly written

and instructive, and shows how dangerous it is to tamper with the balance of nature, as ignorant keepers and farmers are too apt to do. It would be a most useful book for foresters.

While on the subject of books, let me mention two charming old volumes which I recently met with in the library of the Surveyors' Institute. (1) "The manner of raising, ordering, and improving forest trees; also, how to plant, make, and keep woods, walks, avenues, &c. Also rules and tables showing how the ingenious planter may measure superficial figures, and divide land and measure timber in it." By M. Cooke. Printed at the Leg and Star, over against the Royal Exchange in Cornhill, 1676. (2) "A sure method of improving estates by plantations of oak, elm, ash, beech, and other timber trees, coppice wood, &c., wherein is demonstrated the necessity and advantage thereof—their manner of raising, cultivating, felling, &c., whereby estates may be greatly improved. Offered for the consideration of the nobility and gentry of Great Britain, by Batty Langley, of Twickenham. 1728." The precepts enunciated by these quaintly written old books are fully applicable to the present day, although many of their calculations are based on the labourer's wage of their day, viz., 9s. a week.

Education in the sciences which underlie good forestry is the first thing needed. Given that, education in practical forest work, on scientific lines, is easily acquired. The question is, how this education is to be got.

If the State were to work the forests it possesses on reasonable and scientific principles, and with the aim of ceaseless progress in improvements always in view, throwing them open freely to forestry teachers and students, much might be learnt. But alas! at present it is well nigh impossible to obtain practical experience anywhere in the United Kingdom.

Professor Bayley Balfour, in his learned and powerful address on the subject of Forestry, before the Biological Section of the British Association at Oxford this year, has succeeded in awakening fresh public interest in a matter of real national importance. He lays stress on the extremely meagre facilities which, at present, exist for forestry training, and, in dwelling on this, he makes only a passing allusion to one facility which I look upon as by far the most valuable that has recently been established. I suspect he said so little about it because the scheme is his own. I allude to the project which he formed and carried into practice, two years ago, of giving a course of instruction in the science of forestry, combined with horticulture, to working men. He proposed to form a class of well-recommended young men for instruction, free of charge, to be carried on principally in the evenings, at the Royal Botanic Gardens at Edinburgh, providing them, at the same time, with remunerative employment either at the Gardens or, through his influence, with neighbouring nurserymen, so that they might be able to support themselves during their curriculum.

Professor Balfour's scheme solved one of the greatest difficulties which has been felt, namely, the gift of instruction, free, to the very stamp of man at present most needed, and who otherwise would be unable to afford it.

The prospectus which he put forth in 1892 was as follows. I quote only a part of it:—

"By arrangement between the Commissioners of Her Majesty's Works and the Board of Agriculture, a course of study in the sciences underlying the practice and in the principles of forestry and horticulture will be instituted in the month of October of this year, at the Royal Botanic Gardens, Edinburgh, for practical foresters and gardeners.

The curriculum will extend over two-and-a-half years, and will include the following subjects:—Chemistry, physics, meteorology, geology, surveying and mensuration, entomology, botany, forestry, and horticulture, and these will be taught practically as far as possible.

The curriculum will be free of charge to those who are admitted to it.

The times of the classes will be arranged so as not to interfere with the usual hours of labour."

The prospectus goes on to say that applicants must be well recommended, and produce a certificate of character, and that arrangements will be made for employing them, on the usual wages, either in the Botanic Gardens, or in nurseries about Edinburgh.

It was widely circulated in the United Kingdom, among landed proprietors and others likely to aid in giving practical effect to the scheme, with very happy results. In the first year Professor Balfour had 65 applicants, every one of whom had good testimonials and certificates of character. From these 46 were selected, most of whom are now attending the course of lectures and instruction. There have since been 27 other applicants.

The course extends over two years and a half, and, as a result, Professor Balfour expects to send out, next year, his first batch

of 15 foresters, fully competent to undertake the management of any woods of which they may be put in charge. Colonel Bailey, Lecturer on Forestry at the Edinburgh University, has been aiding in this good work by lecturing at the Botanic Gardens. His University Lectureship—which I hope may soon develop into a Chair—will doubtless turn out many an efficient forester of the higher and more expensive class, but a very large proportion of our country squires and landholders can only afford the cheaper article, namely, the man who understands both forestry and gardening, and who will be content with £60 or £100 a year. This want Professor Balfour's scheme is eminently calculated to meet, and his excellent example might well be followed in other botanic gardens.

Some of the technical education schemes of the County Councils embrace forestry as a subject. It is to be hoped that ere long all will do so. The difficulty, of course, at present is to find teachers, and this difficulty cannot be evercome in a day, but, meanwhile, something is being accomplished,

The Forest School, established at the Royal Engineering College at Cooper's-hill, in 1885. maintained mainly, if not wholly, at the expense of India, has also, for some years past, been turning out a succession of highly-educated foresters for the Indian service, and recently the doors of the college have been thrown open also to students not destined for India. They here enjoy the advantage of a scientific and practical education, under Dr. Schlich, late Inspector-General of Forests in India, one of the trained experts whose services were obtained for that country, from Germany, by his distinguished predecessor, Sir Dietrich Brandis. A small tract in Windsor Forest has now been made available for the practical instruction of the college students. This is better than nothing, but it is, of course, wholly insufficient for the purpose, and the students have to be sent to Germany for a forest tour. Before 1885, Indian forest students used to be educated entirely abroad.

The expense of a curriculum at Cooper's-hill is considerable, and far beyond the means of a working man. It may fairly be assumed, however, that some of the trained men who pass through the college, and who do not elect an Indian or a colonial career, will swell the ranks of the qualified teachers, so much needed in England, when suitable opportunities offer; and so, we must hope, the ball of forestry education will roll on.

Up to the present time—that is to say between 1887 and 1894—no less than 71 trained foresters have left Cooper's-hill for service in the higher branch of the Forest Department of India, and besides these, two have been sent to the Gaikwar of Baroda, one to the Cape Government, and one to Mauritius.

It is not too much to say that the establishment of the forestry school at Cooper's-hill College was largely assisted, if not mainly brought about by the action of the Society of Arts. In 1881 the Society appointed a committee to consider the question of education in forestry with a view to directing the attention of Government to the desirability of providing means by which suitable instruction might be given in the science of forestry in this country, and so obivate the necessity of sending students, destined for India and elsewhere, to be educated abroad; and, on the motion of that Committee, the Society, in 1882, presented a petition to the then Secretary of State for India fully setting forth the advantages which would accrue, not only to India and the colonies, but to Great Britain itself, if means for acquainting themselves with the scientific and technical treatment of plantations, woods, and forests were made available at Cooper's-hill, not only to students for India but also to young men aspiring to be efficient land agents and land stewards, and to fit themselves for the more satisfactory management of landed estates in the United Kingdom.

The memorial submitted that no suitable provision then existed at any of our great centres of instruction in this country for the teaching of natural science in its special reference to forestry, nor for the scientific teaching of arboriculture The school was established three years afterwards. But apart from this the Society of Arts has, for very many years past, been a strenuous advocate of the advantages of forestry and forestry education. I could point to more than a score of admirable papers, letters, and articles on the subject which have appeared in the columns of its *Journal* within the last ten years, and the Society is never weary of stimulating public interest, nor of crying out for more facilities of obtaining increased knowledge and education in forestry matters.

At the present time, pending a more advanced state of education, the man most wanted in Great Britain is he who knows how to plant and grow trees, and how to treat,

prune, thin, and preserve them while growing. The man who knows how to cut and convert trees into marketable timber, and to handle and cart heavy logs is of far less importance, but all the same, it is advisable that a forester be an adept at all these operations, and for this he requires practical education so that he may know how to work economically. It is marvellous to see the skill with which the Black Forest labourers handle vast logs, such as we never see in England—balance them to a nicety, on sling carts, with screw-jack and lever, and afterwards guide and manœuvre them along steep and tortuous roads to points from which they can be floated down a mountain stream. And here a further display of trained intelligence is to be seen; but floating operations in Germany have been so often described that I need only say that no description can come up to the reality.

A valuable aid towards education has lately been started at the Surveyors' Institution. I allude to the Forestry Museum which they have commenced to form. The Surveyors' Institution have for a long time past laid down forestry as one of the subjects in the examination of their candidates for diplomas, and it was felt that a museum as an adjunct to their excellent library would be a boon to the young man studying the business of a surveyor or land agent. I hope the President of the Institution will pardon my quoting from his address given at the opening of the session 1893-94, as he explains the object of the museum in far better words than I could:—

"The institution regards itself as an examining, and not as a teaching body, It is, however, one thing to teach, and another to give facilities for learning. We shall not, therefore, be going out of the way in supplying an educational want in connection with our examinations in forestry. We require candidates to recognise specimens of timber, seedling trees, fruits and seeds of trees, and even smaller ligneous plants which should be familiar to the estate agent either as hedgerow plants or perhaps as useful coppice. We even expect some knowledge of the injurious insects and the fungoid diseases of fruit plants.

"But the student anxious to qualify himself for the practical part of these forestry examinations is in a difficulty. Our library, like those of many similar institutions, is well enough equipped with books; but beyond this there is a want of a special museum illustrative of the subject. The museum of economic botany at Kew are too comprehensive. We are not, as surveyors and land agents practising in the United Kingdom, interested in cotton, in tea, in opium, or in many of the timbers of our distant colonies which are not known to trade here. Even the timber museum at Kew is mainly imperial and not British, nor is it directly commercial. The woods of Tasmania and Australia are more conspicuous in it than those of the Baltic or the United States. The authorities at Kew have, moreover, recently dispersed as foreign to their objects the nucleus of a museum of vegetable pathology, which would have been of intense interest to many of those concerned in the management of woodlands.

"A museum containing specimens of timbers used in the constructive arts in this country and of trees commonly grown for profit here, or suitable for such purposes, and including specimens of their foliage, seedlings, flowers, fruit seeds, insects and fungal enemies or others of a cognate character, would be useful and attractive not only to those preparing for our examinations, but also to many of our older members engaged in estate management."

The museum is being organised by Mr. George Cadell, late of the Indian Foreign Department.

An excellent letter from "A Botanist," in reference to Professor Bayley Balfour's Oxford address, appeared in the *Times* last August, on which I venture to make some observations. He remarks that forestry has both a local and a general interest for Englishmen, inasmuch as a timber famine would be as severely felt by Great Britain as by any country in the world. Experts have long seen the importance of this question, but the development of public opinion has not been great. He gives figures to prove that the threat of a timber famine, within a measurable distance of time, is no idle one, looking to the constantly-increasing demand for timber all over the world. The United Kingdom now consumes five times as much timber as it did a century ago, and the difference is not solely due to the increase of population, for the per-centage per individual has nearly doubled. Thus, what with the clearing of forests and their reckless and unnecessary destruction, the ever-growing consumption of timber and the neglect in many countries of securing any adequate reproduction, the relation between the demand and the supply is becoming more critical. I would commend a perusal of this letter to all interested in forestry. It is to be found in the *Journal* of this Society, dated August 31st, 1894, page 810. The concluding words of the letter are pregnant ones:—

"It is indispensable that planting be undertaken under skilled superintendence, and that a sufficient body of trained foresters be obtained. Forestry ought to take the place in English education which it takes in France and Germany, and should also

have its prizes to attract a high class of students. We should do for home forestry what we are doing for Indian forestry. But before all this is likely to take place a well-informed public opinion must be created."

Most European foresters were astonished at the comprehensive and very complete collection exhibited by Japan at the International Forestry Exhibition at Edinburgh, in 1884, consisting of timber specimens, every possible forest product, botanical collections and drawings, plans, &c. — all clearly and scientifically labelled and arranged; and they were not prepared to find that in that marvellous country, which, as we have lately seen, is capable of carrying out a military and naval campaign on a large scale, without a single hitch either in organisation or tactics, a well-established Forestry Department has existed for many years; probably long before anything worthy of the name of forest conservancy was undertaken in Europe.

The Japanese commissioners, Mr. Tokai and Mr. Takasima, although they had never left their own country before, were trained foresters and botanists, and were quite at home with European timbers, trees, plants, and flowers, many of which they had never seen, but which they could at once identify and call by their botanical names.

Mr. Takasima was an accomplished artist, not only in landscape and figure painting, but also as a botanical draughtsman. I have, in my house at Ascot, some of his masterly pictures, which he was good enough to give me, illustrating forests of Thuja and other pines, and showing how the Cryptomeria, which we know only as an ornamental garden tree, is found in Japan of truly gigantic size.

There must be a vast number of landholders, great and small, in Great Britain and Ireland, who can point to some acres of land on their property which do not bring them in more than a shilling or two a year, by reason of their being absolutely worthless for cultivation or grazing. Such men would doubtless be glad if they could see their way, at a small cost, to render those patches of waste ground prospectively valuable for their children or grandchildren; but they don't exactly know how to do it. They have a vague idea that to plant trees would improve the look of their property, but that would mean trouble and expense, and perhaps disappointment, and so things are allowed to slide.

It is here that the State might step in. The Board of Agriculture might, at a cost not worth consideration, maintain a small staff of scientifically trained men, whose services as advisers should be at the disposal, free of cost, of any landholder, however small, who was desirous of forming a plantation, or of improving his woods. A member of this staff, when applied for, should visit the spot regarding which advice was needed, and he would at once be able to tell the proprietor the sort of trees which would best suit the land, aspect, and surrounding conditions, and would otherwise advise him fully as to seedlings, method of planting, cost, &c.

Supposing this to be carried out conscientiously, and with as little red tapeism as possible, I take it there are few men, who went the length of asking for the services of an adviser, who would fail to profit by his advice. Further advice on the after treatment of woods might be made available in the same manner.

Many would probably be astonished at the small cost at which an acre or five acres can be planted. Let us cite larch, fir, Scots, Douglas, spruce, or others, with a few hard woods interspersed. Fencing, stock proof, and with rabbit netting is, of course, the main expense. This will cost about £7 for a single acre, say £20 for five acres. The other expense would be per acre—

	£	s.	d.
Purchase of 3,500 to 4,000 seedlings, two years old, once transplanted (say)	3	0	0
Planting on the L-notch system by spade (say)	1	0	0
Renewing failures second year (say)		10	0

The expense of fencing and planting a single acre would thus be about £12, or for an area of five acres about £45, and so on, fencing against farm stock and ground game included. I think I am well within the mark.

To show how cheaply planting may sometimes be done, I have seen a specification and contract under which 32 acres were efficiently planted in Scotland, in 1887, at a cost of 35s. an acre, with 2,000 Scots fir and 1,500 larch per acre, plants included. Such contract planting, of course, requires close supervision.

In planting small patches, or belts, from an acre to five acres or more, when the soil is at all better than common moorland, the climate fairly good, and the altitude not too great, a few hard woods may, both for amenity and for ultimate timber utility, be planted round the margins or through the

clump, at a cost of only a few shillings more an acre. In the above calculations the soil is not supposed to need draining, but if it does, surface drains of sufficient capacity can be cut at something like 3s. per lineal chain of 22 yards.

The growth of a young plantation is very slow and disappointing at first, but after the first ten years, progress is much more rapid. A new plantation will require absolutely no attention for the first ten years—excepting where drains exist or are required, which must of course be attended to periodically; meanwhile it will have become a good cover for game, and as soon as the trees are sufficiently grown the rabbit-netting may be removed. After about ten years the first thinning will be required. This is a very trifling affair, the cost depending on the locality and the hands available on the property. In many places there may be a market for these thinnings, but if not, all that has to be done is to beat them down, and leave them on the ground as mulching for the remaining trees. Objections may be raised to this on the score that the dead wood may breed insects injurious to the living trees, but I believe that, in practice, this objection need hardly be considered during the young stage of a wood.

When the plantation is from 20 to 30 years old a second thinning should be made which ought to be remunerative for fencing posts, pit props, &c. At 35 to 40 years of age the trees become valuable for timber of second quality, and after they are about 50 years old no further thinnings should be made, the remaining trees—say about 350 to the acre, may be left to attain maturity, and to grow long clean timber. This will be approximately—

Scots fir at 100 to 150 years of age.
Spruce ,, 80 to 100 ,, ,,
Larch ,, 60 to 80 ,, ,,
Hard woods of course much longer.

Think of the area of wood and the number of trees which might be added to the nation's wealth if only a tithe or a hundreth of the available waste land were to be thus utilised. At present England spends £18,000,000 sterling a year on the purchase of foreign timber, and to this may be added £8,000,000 more for minor forest produce, such as tanning bark, wood pulp, resin, turpentine, and various economic articles. Of course neither the whole of the timber, nor of the by-products could be grown in Great Britain, but it may safely be said that two-thirds or a half of it might. While on the subject of planting we may speculate on the possibility of railway companies planting some of the thousands of acres occupied by their embankments. There may be fear of the undergrowth in such places being set on fire by sparks from locomotives, but with common care this danger does not appear to be so real as one would suppose. A section of one of the Administration Reports of the Chief of the Forest Division of the Agricultural Department of the United States deals with this very question, and while deprecating the idea of great danger from the above cause, he gives statistics, in proof, which we may accept as correct. In Prussia, for example, where more than 50 per cent. of the forests are pine, growing on dry soil with railroads running through them, 156 fires of importance occurred in the 10 years between 1882 and 1891, of which 96 originated from negligence, 53 from ill-will, 3 from lightning, and only 4 from locomotives.

In many localities the larch has been found to be the most profitable tree to plant in Great Britain. It is very generally thought that the tree, and consequently its value, has deteriorated in this country by reason of its susceptibility to canker and other diseases. Much has been written on the subject, and there is great diversity of opinion as to the cause, but it is thought by some that its ills are in a great measure due to want of fresh blood, and that a more general importation of foreign seed would be beneficial. The tree, although so thoroughly established in this country, is an exotic introduced from the Tyrol in the year 1738, by Mr. Menzies, of Culdares, who gave it to the Duke of Atholl, and he planted the young seedlings at Dunkeld; subsequently, it was planted to the extent of 8,000 acres by John, fourth Duke, who was justly proud of his plantations. It is said that he was once showing a French visitor through them who, at the conclusion of their inspection, made him a low bow, and said, "My Lord Duke, you have done so much for the larch that in future you ought to be called *l'Archiduc.*"

The larch gives a remunerative return far sooner than any other pine hitherto grown to maturity in England. The timber is much in demand and commands good prices. As an instance, I may mention that this year a friend of mine in Argyllshire found it necessary to thin 200 larches out of the approach to his house. The trees were 55 years old, and the whole lot averaged about three feet girth. On advertising them for sale, standing, he had

an offer, which he accepted, of £1 12s. 6d. a tree all round, the purchaser to cut and remove them, clear away the *débris*, repair damage to the road, clear the ground and make all tidy. I should mention that the trees stood on the side of a hill, down which they were easily slipped to an adjacent sea-loch for conveyance to Greenock. This is an illustration of what the return of an acre of ground containing mature larches may produce, under favourable circumstances, in 50 or 60 years. I have seen sections of five larch trees, the property of that well-known progressive forester, Mr. Munro-Ferguson, of Novar, which gave an average of 71 cubic feet per tree, worth about 1s. a foot. Their ages ran from 40 to 85 years.

One often sees with regret a piece of valuable wooded land, especially on small properties, wholly or partially ruined by want of knowledge as to its after treatment. The trees once planted, the whole wood has been left absolutely alone, conservancy being entirely neglected—no thinning at the proper times, no dead trees or branches removed—ground game and perhaps cattle allowed a free run of the plantations while young, and squirrels abounding, the result being that a wood which ought to be beginning to give a return has become a dense jungle of crowded ill-grown and stunted trees, which must for ever be almost worthless. A great deal of this is due to want of knowledge on the part of farm servants or bailiffs, who, in addition to their other avocations, are supposed to look after the woods; few of such men have had any training whatever in sylviculture, and possess only a rule of thumb knowledge of how many seedlings should go to the acre, and a belief that once the plants are stuck in, and are alive the following year, they may be left alone, and will some day grow into a fine wood.

A few years ago, at a small place which I rent on Deeside, I observed that a vast number of trees in the plantations were badly squirrelled, and I told my keeper to shoot every squirrel he saw. He had shot over a hundred in a few weeks, when one day he met the old ground officer who was in charge of the woods, who asked him what he had just shot. On his replying that it was a squirrel, the old man shook his head and said, "Puir beastie, what a pity, they never do a body any harm." And yet that worthy old man had enjoyed a special allowance for many years for managing the woods.

On the other hand, it is satisfactory to see numbers of woods and plantations giving good evidence of care and judicious treatment on the part of their owners, and promising them and their heirs a profitable return.

Lately, by Her Majesty the Queen's gracious permission, I had an opportunity of going through the Balmoral woods and plantations, under the guidance of Mr. Michie, Her Majesty's forester. From the grand old forest of Ballochbuie, where the Scots firs now standing are known to be from 200 to 250 years old, down to the very youngest plantations, and even to the nurseries and seed beds, the effects of thoroughly good management and true forest conservancy are everywhere apparent. In a property like Balmoral, as well as in most large properties in Great Britain, the preservation of game is an important factor when dealing with forestry, and handicaps the forester to some extent, but it has been found here that good woods are quite compatible with a good head of game. Of course an area which requires reafforestation or planting, must be fenced in from deer and ground game for 20 or 25 years, but with systematic management a compensating area on which the trees have grown sufficiently becomes available to be thrown open.

So long as the love of sport, open-air exercise and adventure remain inherent in the Briton—and it is devoutly to be hoped that it will never vanish, for that love has aided largely in making the Briton what he is—it cannot be expected that landed proprietors who own moors and deer-forests will sacrifice the shooting grounds they prize, or for which they enjoy a high rent, for the sake of a long-deferred prospect of profit from timber; but still there are many thousands of acres of unprofitable land in the British Isles available for wood-culture without sensibly trenching on shooting ground.

A very interesting and important feature of the Balmoral forestry operations is a plantation formed by Mr. Michie in 1885 of Douglas fir. It is about 20 acres in extent and, being situated on the slope of Craig-gowan hill, facing the castle and in the midst of other woods of Scots fir, spruce, larch, &c., the additional variety of rich colour given by the Douglas fir—with some old birches interspersed—is very picturesque. The health and growth of the young trees have been most satisfactory. I learnt that the seed was obtained from trees growing at Murthly Castle, in Perthshire, which were brought from America by the late Sir William Drummond Stewart. The seedlings were sown and treated

after the usual methods as for Scots fir, larch, &c., and then planted into nursery lines at two years old, then again at four years, and were planted out permanently at five or six years of age, by pitting, about ten feet apart in ground where a good many old birch trees were standing. There were very few failures—not more than three or four per cent.

At present, after nine years' growth, the trees average 13 ft. in height, and have a stem girth immediately above the spread of roots of about 1 foot. Some larches were planted through the Douglas firs, but they have been outgrown by the firs. The aspect of the plantation is north and east, the ground slopes rather steeply in these directions, but it is sheltered somewhat by old trees sparsely scattered. No thinning has yet been done, as the trees having been planted pretty far apart it has not been necessary, nor will it be advisable for some years to come. Squirrels do not appear to attack the Douglas fir as they do Scots, larch, spruce, &c., and it is believed to be less susceptible to damage from birds and insects than most others; even rabbits and hares are not fond of it, and only nibble the bark when hard pressed in winter. It grows very fast, and soon makes a good appearance; in unseasonable frosts or high winds, at the time when the growth is soft, the leader is apt to suffer, but on the whole it compares favourably with the larch, and beats the Scots and spruce in rapidity of growth. The altitude of the plantation is 1,000 to 1,100 feet above thr sea. The soil is a rough gravelly loam, with boulders, while the general rock formation is granite. The wood of the mature Douglas fir—the Oregon pine of commerce—is too well known to need comment, but as the tree was only introduced into Great Britain in 1826, it is early to talk of its timber; while still young, however, it takes a place for durability intermediate between Norway spruce and larch. It bids fair to be the coming tree for planting in the British Isles.

Altogether, about 5,700 acres of the Balmoral and Birkhall property is under wood—3,500 acres being old forest, and 2,200 acres plantation of various ages, chiefly Scots pine, but a good deal of larch and spruce.

There are three saw-mills at work, cutting up the timber for the market, one, near Danzig Shiel, is driven by a steam-engine whch burns sawdust as fuel, another at Invergelder, near the castle, is driven by water, and the third is at Birkhall.

Although I did not presume to ask the question, the whole state of the Balmoral woods, and the efficient method of caring for them and working them, gave me the impression that they could not fail to produce a fairly remunerative return, notwithstanding a more liberal outlay on roads, drives, bridges, fencing, &c., than would be considered necessary under other circumstances and on other properties.

There is an enclosure in the New Forest, Hants, 80 acres in extent, which was planted 50 years ago with Douglas fir and Deodar, in which the former is succeeding admirably, while the latter has not done well. The Royal Scottish Arboricultural Society on the occasion of their visit to the New Forest last year, described the growth of the Douglas fir as "a most pronounced success." There is also a plantation of this fir at Scone Palace in Perthshire 13 acres in extent. It is now 40 years old. In growth they have outstripped all other pines, and in the flower garden there is one, which at 50 years of age was 75 feet high with a girth of 7 feet.

I am not aware whether the Wellingtonia has ever been tried in England as a true plantation. It seems to me a tree which may be suited for cultivation for future profit. In nearly every part of this country we see it well established and evidently flourishing. I have watched the growth of a belt of them at Buckhurst Park, on the border of Windsor Park, for upwards of 20 years, and their progress is astonishingly good. They were planted 32 years ago, and their average height is now about 70 feet, and their girth 6 feet. Although the wood of the Wellingtonia does not equal other woods for building purposes, many uses may be found for it, and taking its rapid growth into consideration, quantity may perhaps be found to compensate for want of quality.

Taking good care of woods is one thing, but to go to the expense of increasing their area, or of forming new plantations, is another—for it is hard to get over the fact that a man hardly ever plants for himself, but for his children and children's children. Few men who plant trees can hope to live to see them grow into a goodly wood or forest, from which they can derive any immediate return, and the satisfaction they feel at having increased the beauty of their property, and its value for those who come after them, must be their main reward.

But judicious treatment of growing trees and their proper conservancy, is within the power of every man at a very insignificant cost compared with the return which he and

his heirs will obtain sooner or later. At the same time he confers a direct benefit on the nation by increasing, to however small an extent, the timber and fuel supply of the country, and he furthers the beneficial influence which trees and woods undoubtedly exercise on climatic conditions. That wooded areas do exercise a marked effect on climate, rainfall, and soil is now a fully accepted fact, and there is no want of evidence in various parts of the world of the direct and often the almost immediate effect of denudation. One has only to point, as a recent illustration, to the large clearances made in Southern India for coffee, tea, and chinchona plantations, and for the old "coomrie" cultivation, where perennial streams have dried up within a few years of the disappearance of the forest from which they took their source.

On the other hand, look to the wonderful effects known to have been accomplished in France by planting the sand dunes along the coast, and 2,000 square miles or more, in the Landes of Gascony with the maritime pine.

In the New Forest the State possesses an area of about 63,000 acres, 40,000 of which is unplanted and unprofitable open heath; 4,500 acres is open land with timber trees on it; 6,500 acres is open plantation, and the remainder enclosed plantations, varying in age from 100 years to 25. On paper this looks like a promising field for a good display of State forestry and forest management, and so it might be if the State were in earnest; but, after frequent agitation and legislation, an Act of Parliament passed in 1877 ties the hands of the officials in charge of the New Forest carefully behind their backs. Nothing can be done towards encouraging a natural reproduction of trees when the old ones are gone, nor can any new planting operations be undertaken. In fact, under that Act, the New Forest must remain merely a uselessly gigantic recreation park and a grazing ground for cattle, and ponies belonging to people of the neighbourhood who have ancient communal rights. I am a great admirer of the New Forest pony myself, but I really don't think he is good enough to stand in the way of re-afforesting many thousands of acres which the State sorely needs. One would think that 11,000 acres of beautifully timbered open land and plantations would be enough for the most ardent lovers of wild woodland scenery, and for the excursionists who visit the New Forest in summer. It is of course the bounden duty of a State to recognise and respect communal rights, but it would surely be possible to purchase these up, as was done when we began our experimental conservancy scheme in Southern India in 1848. The New Forest commoner would probably be quite ready to sell his right to very bad grazing, and to collect peat where little peat exists for a reasonable price, if he were fairly and liberally dealt with.

The State also possesses in Windsor Forest an area of over 11,000 acres, and extensive woods at Swinley and Sandhurst; also the Forest of Dean consisting of 20,000 acres, which has been State property from olden time. All this, and much more in other parts of England, might be immediately available for the extension and for the maintenance of forests on scientific rotation principles, and as training grounds for the foresters, so much needed.

Windsor-park, that right royal demesne which has no equal in the wide world, is full of object-lessons for the sylviculturist. The grand old pollard oaks, supposed to be 800 or 1,000 years old, can be admired, but they can never be replaced when they die out. There are many highly instructive plantations, both in the Park and in Windsor Forest, from which much may be learnt. The oldest oak plantation known in England exists here—it is about 13 acres in extent, and was planted in 1580. One feature of the excellent management that Windsor-park and Forest enjoyed, and still enjoys, is that the date of every new plantation, as far back as about two centuries, is recorded on metal posts, so that the comparative growth of various trees can be seen at a glance. The area of Windsor-park alone is about 3,000 acres.

The whole of England contains about 32,000,000 acres of land, of which 1,614,000 only are woodlands. Scotland has an area of 19,000,000 acres, of which rather less than 1,000,000 are wooded. Ireland is over 20,000,000 acres in area, and has less than 350,000 acres of wood. Wales is nearly 5,000,000 acres in area, and has 175,000 acres in wood.

It will thus be seen that Great Britain has only about 4 per cent. of her total area covered with wood, great and small, while in other countries it is, roughly speaking, as below:—

France	15 per cent.
Germany..................	25 ,,
Norway	25 ,,
Austria and Hungary	30 ,,
Sweden	40 ,,
United States of America..	25 ,,

The need for reafforesting some of the many millions of waste acres in Ireland has been much talked of and written about, aud there is no doubt of the need of it if it could be accomplished. But I don't see how very much can be effected in this way, of a satisfactory character, excepting by State aid given with a side view to providing employment for the people.

When I was Commissioner for India at the Edinburgh Forestry Exhibition in 1884, I had many talks on the subject with the late Dr. Lyon, M.P., and read many of his writings about it. He was an enthusiast on the point, and was deemed a visionary, but I thought him visionary only in that he believed that the Government of the day would soon see their way to providing funds for creating State forests in Ireland on an extensive scale. His views as to the effect which a great scheme of the sort contemplated by him, would produce on the prosperity of his country were sound enough, but general interest in forest matters was more languid then than it is now, and even the Parliamentary Select Committee, of which Dr. Lyon was a member, did not succeed in attracting and securing much attention to its report and suggestions. The subject is far too large a one for me to further take up here, but I have lately heard a rumour that a very capable advocate of it will shortly appear on the scene.

One word more. I should not be true to the country in which I have passed so many years of my life, and to which I owe most of the prosperity I enjoy, if I did not claim for India the credit of having, by her marvellous successes during the last half-century, set in motion and stimulated the recent tide of public interest in forest conservancy throughout the colonies, and in the United Kingdom itself.

Ceylon, New South Wales, New Zealand, the Cape, Mauritius, Jamaica, and Cyprus have all borrowed officers from India to put them in the way of organising conservancy and the economic working of their forests, and it is only within the last twelve years that the United States Government has instituted a Division of Forestry in their Department of Agriculture, and formed an establishment which, judging from some of the annual reports I have seen, cannot fail to confer lasting benefits on America. The present head of the Forest Department at the Cape, the Conservator in Ceylon, the Professor and the Assistant-Professor of Forestry of Cooper's-hill College (Dr. Schlich and Mr. Fisher), the Lecturer on Forestry at the Edinburgh University (Colonel Bailey), the editor of the new edition of Brown's "Forester" (Dr. Nisbet), the late president of the Royal Scottish Arboricultural Society (Dr. Hugh Cleghorn), and, last but not least, Sir Dietrich Brandis, who still aids in the education of Cooper's-hill students, all are Indian forest officers.

Turning to our colonies and dependencies, we see at once the beneficent results of their having followed India's lead. Ceylon has a fully organised Forest Department, consisting of a Conservator, with an assistant, in each province, with a staff of foresters. The Straits has a Director of Forests, who is also director of the Botanic Gardens, with various forest officers under him. New South Wales has an establishment of 64 forest officials, at first under a separate director, but now merged with their Department of Agriculture. South Australia has had a successful Forest Department since 1882, consisting of a Conservator and 11 other officers. Victoria has a Conservator, appointed in 1888, with a staff of 28 officers and subordinates. Tasmania has had a Conservator since 1880. The Cape has a Conservator with four officers under him. Mauritius has had a Forest Department for 15 years, consisting of a Director and 16 subordinates. Cyprus has a Principal Forest Officer, with a staff of 44 minor officials. I need not go further.

We have reviewed what most of the nations of the world have done for forestry. Is it not sad and humiliating that the United Kingdom alone hardly lifts a finger to further a science which is of such immense and far-reaching national importance?

DISCUSSION.

Sir GEORGE BIRDWOOD said that General Michael had favoured them with a valuable and most interesting paper, and to him, and he was sure to many others present, it was particularly interesting in so clearly tracing the earnest attention that was now being given to the revival of scientific forestry in the United Kingdom to the remarkable success that had resulted from its introduction into India. There was only one point of importance he had omitted in his brief retrospect of the really romantic history of the Forestry Department in India, and that was the mention of the person in whose labours it practically originated. It was fifty years ago and more, in the good old days of the East India Company, that two young

subalterns were serving their country in the 39th Madras Native Infantry, who both took what was then considered almost eccentrically original lines of work quite outside the usual military duties of the time. One of these young men was Lieutenant William Fothergill Cooke, who, after working out his first tentative experiments in electric telegraphy, by means of wires hung round his bungalow, gradually achieved such success that he imported his invention into this country, where, with the assistance of Wheatstone, he brought it to such perfection, that in 1867 he and Wheatstone were jointly awarded the Albert Medal of the Society of Arts; and the further honour of knighthood was conferred by her Majesty on both of them. The other subaltern referred to was the gallant general who has lectured this evening. He took up the subject of forestry. Our distinguished Chairman this evening, in his "Report on the Moral and Material Progress of India, in 1872-73,"—the "Model Blue-book." as it was at once described, on its publication, by the *Saturday Review*—informs us that General Michael was entrusted by the Government of Madras, in 1848, on the recommendation of General Frederic Cotton, with the organisation of a small establishment for working and conserving the public forests in the south of the Madras Presidency. Attempts which were made about the same time in Bombay and Tenasserim met with no success, partly from being commenced on too ambitious a scale, and partly owing to insufficient consideration of the ancient forest rights of the people. General Michael set to work in a more modest manner, and in a far more conciliatory spirit, and after six years his exertions, which completely broke down his health, were crowned with such success that the Court of Directors in London at once took the subject up warmly, and rapidly extended the Madras system of forest conservancy over all India, and as much of Farther India as was then under their rule. In those days it was an almost unheard of honour for a subaltern to be mentioned by name in a despatch of the Court of Directors, but General—then Lieutenant—Michael received that honour in 1854, and a great career was now before him; but, unfortunarely, he had to be invalided home in 1856, when the Forest Department, which was then regularly organised, was placed under the direction of the late Dr. Hugh Cleghorn, with Captain (now General) Douglas Hamilton, and Lieutenant (now Colonel) Beddome as his assistants. Under Cleghorn, and his successor, Sir Dietrich Brandis, the operations of the department were pushed forward with such energy and ability that it now includes in its *personnel* about 200 superior officers, and over 12,000 subordinate officials; and it has not only saved the forests of India for ever, but is earning a net annual revenue of half a million sterling. Few pioneers live long enough to see the work of their early lives blest with such beneficent and truly stupendous success. General Michael deprecates his want of scientific knowledge of forestry. But he provided the experience which is the basis of all scientific work and he is pre-eminently possessed by an innate, unfeigned love for woodland lore, without which a scientific knowledge of forestry would be barren of all practical result, and which was the real source of his success in Madras, as it is of the charm of his lecture here to-night. It is indeed instinctive in the whole Aryan race, which from its earliest migrations has been associated with that great forest belt, once extended across the entire breadth of the Euro-Asian continent, of which the Black Forest in Germany, the Ardennes Forest in the North of France, and the remains of Andred's-wood in Kent and Sussex, and the New Forest in Hampshire, which once linked Andred's-wood with the Forests of Dartmoor and Exmoor, and the Dean Forest, are now isolated fragments. It was in this vast temperate forest belt, extending from the Himalayas, along the Caucasus, and the Imaus, and the Balkans, Alps, and Appenines, to the utmost British Isles, that the ancestors of the ancient Hindoos and Persians, and Greeks and Latins, and of the modern Celts, Sclaves, and Teutons, learned their common names for the alder, apple, ash, aspen, beech, birch, elm, hazel, holly, linden, maple, oak, pine, and willow; and that the European Aryas learned to worship the oak as the king of the woods, and their highest god. From Dodona to Leatherhead—"the High Oracular Grove"—the oak was associated with the supreme god of the Aryas, either as his sanctuary or the godhead's self. The love of trees is as strongly marked in the British and Anglo-Saxons as in every other branch of the Aryan race. I have made out two lists of place names in Great Britain, the first being of places named after woods and clearings in woods, and trees generally, and parts of trees; and the second of places named after trees. The following places in Great Britain derive their names from British, Anglo-Saxon, and Danish words signifying woods or groves, clearings in woods, trees generically, the branches, trunks, stems, and boles of trees, and timber. Thus, from the Anglo-Saxon *beam*, a tree, we have Bemfleet, in Essex, Bampton in Oxfordshire, and Bamford Speke in Devon; and from the Anglo-Saxon *treow*, a tree, Treborough in Somerset, and Treeton in Yorkshire; from the Danish *thufe*, a branch, Tufton in Hampshire; from the British *bon*, the bole of a tree, Bungay in Suffolk; from the Anglo-Saxon *bol*, bole, Bolton in Lancashire, and seven other Boltons, Bole in Northampton, Newbold in Derbyshire, and Bolingbrooke in Lancashire; from the Anglo-Saxon *stib*, bole, Stibbard in Norfolk, Stibbington in Hampshire, Steeping in Lincolnshire, Stebbing in Essex, and Stepney in Middlesex; and from the Anglo-Saxon *stoc*, tree stock, stem, or trunk of a tree, over 100 names of places, including Stoke D'Aberon in Surrey, Stogussey in Somerset, Stoke Say in Shropshire, and Grey stoke in Cumberland; from the Anglo-Saxon *tymbre*, wood, Timberland in

Lincolnshire, and Timberscomb in Somersetshire. From the British *bar*, a bush, we have Barcomb in Essex, and Barlow in Derbyshire, ; and from the Danish *bosch*, a bush, Buscot in Berkshire, and Bushey in Hertfordshire, and elsewhere. From the British *coed*, a grove or wood, we have Coed-Arthur, Argoed, Coyty, and Disgoed all in Wales; from the Anglo-Saxon *bærw*, (compare British *bar*, a bush), a wood, a grove, Barrow in Leicestershire, and elsewhere, Barrow-in-Furness in Lancashire, Barrowden in Rutland, Berrow in Worcestershire, Burwarton in Shropshire, Berry Pomeroy in Devonshire; from the Anglo-Saxon *holt* a wood, *i.e.* hold of wild beasts, Bergholt in Essex; from the Anglo-Saxon *hyrst*, a wood, over 70 names of places, including Hurstmonceaux and Billinghurst in Essex, and Deerhurst in Gloucestershire; from the Anglo-Saxon *wæald*, or wild woodland, Weald Bassett in Essex, Woldingham in Surrey, Woldford in Warwickshire, Old in Northamptonshire, Old Castle in Herefordshire, and Oldberrow in Worcestershire; from the Anglo-Saxon *scua*, a wood, Shaugh and Shaugh-Prior in Devonshire, Shawbury in Shropshire, and Shoebury in Essex, from the Anglo-Saxon *wuda*, a wood, Outwood in Lancashire, Woodsetts in Derbyshire, and Sherwood in Nottinghamshire; from the Danish *skeg*, a wood, Skegby in Nottinghamshire, and Skegness in Lincolnshire; and from the Danish *toft*, a wood, surrounding a house, 30 names of places, as Toftwood in Suffolk and Norfolk, and Tofthill in Durham. From the British *den* and *denan*, and Anglo-Saxon *dene*, a woody dingle, we have Hastingdene in Kent, Rottingdean in Sussex, and the Forest of Dean in Gloucestershire [compare Devon, the "deep valleys," *deifneint*]. The Anglo-Saxon *plump*, a clump of trees, gives its name to Plumpton in Sussex and Northamptonshire; and the Anglo-Saxon *hleothar*, or *oracular*-grove, to Leatherhead, "the High Oracular-grove." The Old French word *forest* [from the Latin *forestis*, lying without, through the Low Latin *foresta*], signifying an open woodland [as distinguished from an enclosed one, or park], in which the King's rights of the chase were reserved, is found in the names of Forest gate in Essex, Forest hill in Kent, Forest row in Sussex, and of the Forest of Dean in Gloucestershire, the New Forest, Hampshire, &c. Its association with hunting is seen in the name of the town of Huntly, "the land for hunting," on the borders of the Forest of Dean; and, again, in the names of several places near open woodlands compounded with the word chase, as Enfield Chase and Cannock Chase. From the British *clawr*, in its Anglo-Saxon form, *clere*, a clearance in a forest, we have Clawrplwyf in Wales, and High-clere and Kings-clere, both in Hampshire. From the Danish *thwaite*, meaning the same thing, we have upwards of 40 names of places in Norfolk, Suffolk, and other eastern and northern counties; from the Anglo-Saxon word *royd*, a road cut through a forest, Huntroyd and Mytholmroyd, both in Yorkshire; and, finally, from the Anglo-Saxon *erwd*, ploughed woodland, we have Erwood or Erwd, in Breconshire, Wales. The following places in Great Britain derive their names from the British, Roman, Anglo-Saxon, and Danish names for special trees. Thus the Alder gives its name from the British *gwern* to Vern [literally the Alders] in Herefordshire; from the Anglo-Saxon *alar* to Alresford in Hampshire, Alrewass in Staffordshire, Ellerton in Northumberland, Orleton in Herefordshire, and Orleston in Kent; and from the Norse *embla* to Embleton in Durham, and Emley in Yorkshire. The Apple, in British *æpl*, *apal*, and *aval* [Avalon] to Applethorpe in Nottingham and Appuldercombe in Devonshire. The Ash, from the British *onn* to Llwyn-onn, "the Ash-grove," in Wales, to Machen [plural form] in Monmouthshire and the river Onny in Shropshire; from the Anglo-Saxon *aesc* to upwards of 120 places, including Axminster, and possibly the river Exe [which is probably *Usk*, if *Oxus*, and *Ox*ford, water] and Exeter, in Devonshire, and Axbridge in Somerset; from the Danish *aesc* to Askrigg in Yorkshire, and to several places called Askham in Nottingham, Yorkshire, and Westmoreland. The Aspen, from the Anglo-Saxon *aeps*, to Epsom in Surrey, Epworth in Lincolnshire, and probably Ipswich in Essex, and from the Danish *asp*, to Apsley-Guise in Bedfordshire, and Aspeden in Hertfordshire. The Elm gives its name to nearly 40 places, including Helmshore in Lancashire, Helmsley in Yorkshire, and Helmdon in Northamptonshire. The Beech from the British *fedw*, gives its name to Llwelyn-y-fedw in Wales [it seems to lurk also in the later etymology of Hereford], and from the British *bæcen* (beeches) to Beckenham in Kent, and Beckingham in Nottinghamshire; and from *bæce* (beech) to Bixton and Bickleigh in Devonshire, Bicknor in Monmouthshire, Bicker in Lincolnshire, Beecham Well in Norwich, and Burnham-beeches in Buckinghamshire; from the Anglo-Saxon *boc* to Bocking [*bocen* "the Beeches"] in Essex, Bockleton in Herefordshire, Boxford in Suffolk, and to Buckingamshire. The Birch from the British *bedw* (compare *fedw*, beech) gives its name to Bedwethy in Monmouthshire, and Beddoe in Shropshire; and from the Anglo Saxon *birce*, to Birchington and Birchholt in Kent, Birkham in Nottinghamshire, and Berkeley in Gloucestershire. The Cherry, from the Latin *cerasus*, has been thought to give its name to Cherry-Hinton in Cambridge, to Cherhill in Wiltshire, and to several places called Cheriton. The Hawthorn gives its Anglo-Saxon name to nearly 100 places, including Tring in Hertfordshire, and Thurning in Norfolk. The Hazel, from the British *celli*, gives its name to Pencelli, and Tregelli in Wales; and from the Anglo-Saxon *hæsl*, to Haslingdene in Kent, to Hessle and Heslington in Yorkshire, Haslingden in Lancashire, and Hesley in Warwickshire, and elsewhere. Nutfield in Surrey, Notting-hill in London, and Notgrove in Gloucestershire, are called after its nut. The Holly, from the British *celyn*, gives its name to Cwm-celyn in Mon-

mouthshire, the Chin river, and Chingunford in Shropshire, to Collington in Cornwall, and Calne in Wiltshire; and from the Anglo-Saxon *holegn* to Holne in Devonshire, Hollington in Sussex, Olney in Buckinghamshire, Hollesley in Suffolk, and Alnwick in Northumberland. The Linden or Lime gives its Anglo-Saxon name to Lindsell in Essex, Lyndhurst in Hampshire, and Lindridge in Worcestershire. The Maple gives its Anglo-Saxon name to Maplebeck in Nottingham, Maple Durham in Oxfordshire, Mapleton in Derbyshire, and several other places. The oak, from the most ancient British *dar* (compare *darwydd*, "druid") gives its name to Darlin, in Monmouthshire, and, indirectly, to Redruth, the "Druids-town" in Cornwall; and from the Saxon *æc*, to Acton in Middlesex, and elsewhere (eight places all so-called), Acaster, Acklam, and Ackworth in Yorkshire, Acomb in Durham, Acrise in Kent, Green Cryse in Herefordshire (where its *corn* or "seed" gives its name to Acornbury, as in Wales it does to Festiniog, the "acorn-land" of Merionethshire), to over 20 places called Oakham, Oakington, and the like, and to about six places in which *oak* becomes *oc*, or *ock*, as Occold in Suffolk, Ockbrook in Derbyshire, Ocle in Herefordshire, and Okeover in Staffordshire. Glastonbury is called after the British name, *glastennen*, of the helm-oak; Berkshire takes its name from the polled ("pollard") oak, under which the shiremotes of that county were anciently held; while the name of Sherwood is similarly derived from the oak (here generically *wuda*), under which the shiremotes of the County of Nottingham were wont to assemble. The Pear gives its Roman name to Purley, Purleigh, and Pyrford in Surrey, Parndon in Essex, Parham in Suffolk, and Paracomb in Devonshire. The Pine gives its Anglo-Saxon name to Pinner in Middlesex, Pinefern in Dorset, Pinhoe in Devon, and Punchestown in Wales. The Plum gives its Anglo-Saxon name to several Plumsteads in Norfolk and elsewhere, and to Plumbland in Cumberland. The Privet gives its British name *yswydd* to places in Wales, and, finally, the Willow gives its several Anglo-Saxon names, *pursh*, *sahl*, *wil*, *windle*, and *withig*, respectively to Pershore in Worcestershire, Soho ["Willow-hill"] in London, Soham in Cambridgeshire. Salehurst in Sussex, Saul in Gloucestershire, Salford in Lancashire, Soulbury in Buckinghamshire, Souldern in Oxfordshire, Willoughby in Lincolnshire, and elsewhere, Windle in Gloucestershire, Windsor in Buckinghamshire, and a dozen Withams, Witherns, Withingtons, and the like, in Suffolk, Lincolnshire, and elsewhere. You will observe that there are about 500 such place names: and what is so remarkable is that the trees thus toponomically commemorated are, with the possible exceptions of the cherry and the pear, all trees which were the indigenous forest trees of these islands before the invasion of Julius Cæsar; and the very trees I have already cited as having a radically common name among the principal Aryan races. It proves how trifling has been the influence on the Aryas of the 2,000 years of their civilised history in comparison with that of their 15,000 to 25,000 savage history; which some would indeed extend to 50,000 years. The Romans are generally supposed to have neglected the administration of the forests in these islands. Still they would appear to have added the box, the sycamore, and the laurel to our woods, and the cherry, pear, medlar, quince, mulberry, fig, damson plum, vine, chestnut, and walnut to our orchards and homestead plantations, and they thus immensely and permanently increased the horticultural productiveuess of the country. There is positive evidence of the care for our forests shown by the Anglo-Saxons and Danes. One of the Saxon kings instituted a fine of 60s. for burning a fire in any wood, "for fire is a great thief." Canute levied a fine of 20s. on anyone cutting brushwood without permission, or destroying trees and shrubs used as fodder for cattle; and in every county during the Norman times the Sheriff was made accountable for the conservancy of all woods. From "Domesday Book" and the "Codex Diplomaticus" a very good idea may be obtained of the extent of the contemporary forests in Great Britain, and the general conclusion one comes to from the survey is that there is no country in the world which would better repay sound and systematic conservancy than these British islands. They seem to afford a kindly home to every robust timber tree, and temperate fruit tree, and hardy flowering plant. They are, indeed, one of the world's great natural paradises. Where we have lost our forests it has been through sheer stupidity; the most terrible example of this being the disappearance, in greater part, of the famous Andred's-wood, which once covered all the waste lands of Kent, Sussex, and Surrey, and extended along the "Saxon shore" into the present New Forest, in Hampshire, but was almost totally destroyed in the 17th century by the reckless iron smelting then carried on in our south-eastern counties. He could not resume his seat without expressing what pleasure it had given him to find Mr. Clements Markham presiding there that evening. All the time that gentleman was in the public service he had exerted his great abilities in the furtherance of every measure calculated to develop the reproductive resources of India. His name would be imperishably connected with the introduction of the Peruvian chinchona trees into India, which now produced one-third of the quinine consumed in that country, and about one-sixth of the chinchona bark imported into the United Kingdom. General Michael would feel it an honour, and all present felt it a great honour, therefore, that Mr. Markham was in the chair on the present occasion.

Sir JOSEPH FAYRER, K.C.S.I., F.R.S., after expressing the pleasure which it gave him to be present, and to hear the paper, said he had

no special knowledge of forestry, but he had been in India for many years, he was a sportsman and a traveller, and he knew something of the advantages of woods, and how much they contributed to the welfare of the country, and how their absence or destruction tended towards its deterioration. He had frequently had before his eyes instances of great countries which had been devastated, the population diminished, and the whole physical conditions damaged simply by the destruction of trees. He had also had the opportunity of seeing how re-afforesting and encouraging the growth and culture of trees might restore a country to a state of salubrity, and bring back that condition of well being which without them could not exist. He had observed of late a growing tendency to ascribe the great benefits accruing to India from the rapid development of the forest system to the Forest Laws; and, it seemed to him, that in giving a due meed of praise to the distinguished scientific men who controlled that department, they had forgotton the basis on which that superstructure had been built. That they had a forest system in India now, which was, by imitation, extended to many other parts of the world, was due almost entirely to certain men, who thought, and wrote, and worked on the subject many years ago, amongst whom was the reader of the paper. If he were to go back to the beginning he should have to refer to McClellan, Wallace, and others, who pointed out the need for these things; and later on he should have to speak of Gibson, of Bombay, of the scientific father of forestry in India, Dr. Cleghorn, and to the father and pioneer of practical forestry in India, General Michael. It was therefore a great satisfaction to him to hear so great an authority as Sir George Birdwood say what he had; and he only wished the facts were more widely known. General Michael was far too modest; he was certainly one of the great benefactors of India, and it was a great pleasure to him to hear, in this practical paper, the same principle applied to Great Britain which had proved so beneficial in India. It made one almost ashamed to see, when travelling almost anywhere on the Continent, how comparatively well the woods were cared for, and how they were neglected in our own country. There were miles and miles, especially in the north, where there were only little bits of cover here and there, thoroughly neglected and of no use at all, except, perhaps, as shelter. There was no knowledge and no care; trees were planted and left to grow, or be blown down by storms, and there was practically no re-planting. If such hints as General Michael had given were followed even in a small measure, an enormous amount of benefit would accrue, and he hoped this paper would do some good. But the advice must be constantly repeated, and he was glad to think that some things were now being realised which were advocated in that room twenty years ago or more, and which then seemed almost hopeless. He hoped it would be the same with forestry in the future. India had shown the way, for her forest system was now a splendid one; it was of the greatest importance to the country from a sanitary point of view to his own knowledge; and it must also be very important agriculturally and commercially. He could remember the time when he used to shoot in the Terai, and often saw large trunks of trees which had been set fire to smouldering on the ground, and large tracts of grass blazing, and doing an immense amount of destruction to the forests; destruction of the most wanton kind. But that was not the case now, the trees being carefully preserved. England had done a great deal towards educating scientific foresters. The school at Cooper's-hill was an excellent one, presided over by a first-rate man, Dr. Schlich, and he hoped it wouid be maintained and well supported, not starved from any false notions of economy; for if the scientific forestry of India were abandoned, it would entail immense evils on the country and the people.

The CHAIRMAN said they would all agree that this paper would have an excellent effect in furthering the efforts of the Society of Arts to develop forest conservancy in this couutry, strengthened as it had been by the excellent remarks of Sir George Birdwood and Sir Joseph Fayrer. His own studies of late years had been concerned mainly to the geographical aspects of foreign conservancy and forestry; and the physical changes caused in the earth's surface by the destruction of forests. He had been shocked to see on the western side of the Peloponesus the wanton destruction going on in about the only part of Greece where there was any park-like scenery at all. Those who remembered their Theocritus, and had been in imagination to those shady groves, and listened with Lycidas and Thyrsis, would be shocked, as he had been, at seeing the climatic condition of Sicily at the present day, and the destruction of its fine vegetation. He did not mean to say there were no oak forests in Sicily, but they were so small that no ordinary traveller ever saw them. Again, on the way to India, one looked at the hills of Andalusia, and at present one could only compare them to the shore of the Gulf of Suez. Yet they knew that in the 13th century, when the Moors were driven out of Spain, those hills were clothed with pine forests, for records still existed. The forests were wantonly destroyed, the soil disappeared, and now there was nothing but a mass of naked rocks and pinnacles pointing up into a rainless sky. There had been a complete alteration of the climate and of the whole conditions of the country. All the Southern Mediterranean had undergone the same sort of change; its magnificent oak, chestnut, and beech forests of classical times had given place, except in a few favoured spots, to cut vines and aloes, and

the climate had also deteriorated. In many other parts of the world the same thing was observed; so that the uneducated man thoroughly beat the goat, as the most mischievous creature in creation. He believed that, before another generation passed away, they would not look in vain to the rulers of this country, who would understand the vast importance of forest conservancy; and when once they understood it, they would see that it was not only a duty but a necessity to think and work for posterity, and not merely for a plausible balance-sheet. As had been pointed out, British India had set the mother country a good example, and when he remembered the many magnificent plantations made in 1843, he was reminded that General Michael was the first pioneer of many in this beneficent work in South India. In this paper he had pointed out how a useful beginning might be made in this country. In the first place, he referred to the work which might be done in the education of foresters, and made an excellent suggestion that the Government might be induced to furnish help and advice to persons undertaking planting. During the last seven years he had been in charge of some large estates in Yorkshire, where he had to do a considerable amount of planting, and over and over again he had felt the want of a really good trained forester to help and advise him. Such a step, therefore, would be in the right direction. There was now an admirable system for training higher forest officers at Cooper's-hill; and Professor Balfour had instituted an admirable scheme for the instruction of foresters; but a great deal more was required, if they were to save the climate from deterioration, and to reafforest the wilds and moors which once yielded valuable timber. The Society of Arts had done a great deal in furthering these objects, and he congratulated it on having brought so able a worker as General Michael to their aid. He concluded by moving a cordial vote of thanks to him for his paper.

The vote of thanks having been carried unanimously,

General MICHAEL, in reply, said I esteem it a great honour that the Society of Arts had placed in the chair this evening the distinguished President of the Royal Geographical Society, who is so well known—as Sir George Birdwood has told us—as having, at great personal risk and labour, accomplished the benificent work of obtaining the cinchona tree from Peru, and introducing it into India, in 1860. There are now, I may say, whole forests of the tree in that country, and, as a result, quinine, that once expensive febrifuge, had been brought within the means of the poorest in the land. Packets which, 30 or 40 years ago, would have cost several shillings, are now sold in great quantities to the people at nominal prices, which may be reckoned by farthings. For this important service Mr. Clements Markham received the *Grand Prix*—the highest possible distinction—at the Paris Exhibition of 1867, an honour which was conferred on very few men indeed. I must now thank him for presiding; I must also thank those dtstinguished gentlemen who have spoken in such interesting and instructive words; and I personally thank Mr. Markham and them for the kind and gratifying manner in which they have alluded to myself.

General Notes.

CHRISTMAS LECTURES.—The first and second lectures of a course on the "Work of an Electric Current," by Prof. J. A. Fleming, F.R.S., will be delivered at the Royal Institution on Thursday, December 27th, and Saturday, 29th, respectively. The first lecture of a course on "Holiday Geography," by Dr. H. R. Mill, will be delivered at the Royal Geographical Society on Friday, 28th. The first lecture of a course on "English Cathedrals," by Arnold Mitchell, will be delivered at the London Institution on the 28th inst.

PHOTO-ENGRAVING WITH SILVER SALTS.—At the last meeting of the Royal Photographic Society, Mr. Leon Warnerke gave a demonstration of a process for photo-etching partly dependent on sensitive silver salts instead of bichromated gelatine. A negative of the original is taken in the usual way through a screen. After the negative is developed and dried, it is given a safe edge. The next step in the process is to place the negative in contact with a sheet of paper coated with gelatine pigmented with a sensitive silver salt, such as the bromide, and making an exposure, the image being developed with pyro-ammonia. After development, the image is pressed or squeegeed in contact with a copper plate previously polished with snakestone and charcoal, the paper backing and the soluble gelatine, together with the unaltered silver salt, being removed by hot water in the same manner as a carbon image is developed. After washing and treatment with alcohol, the plate, when dried, is ready for etching with perchloride of iron in the ordinary way. The process, Mr. Warnerke pointed out, might be adapted to photogravure purposes by commencing with a transparency instead of a negative, and transferring the developed negative to the plate grained with asphaltum, the subsequent operations being as usual. The process is an outcome of the negative paper process brought out by Mr. Warnerke in 1880, and described by him in the paper he read before the Society in 1886.

Journal of the Society of Arts.

No. 2,197. Vol. XLIII.

FRIDAY, DECEMBER 28, 1894.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 2 and 9, 1895, by Professor C. Vernon Boys, F.R.S., on "Waves and Ripples."

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. A few cards still remain, for which members should apply at once.

Proceedings of the Society.

CANTOR LECTURES.

EXPLOSIVES AND THEIR MODERN DEVELOPMENT.

By Professor Vivian B. Lewes.

Lecture I.—Delivered November 20, 1894.

The ordinary phenomena of combustion, which supply us with warmth and light, are all dependent upon the evolution of heat during chemical combination, and a study of combustion has shown us that by slowing down the rate at which the chemical actions are taking place, we can obtain those phases of combustion in which the heat is developed so slowly that it has ample time to dissipate itself into the air or to surrounding objects, and although the chemical actions are still proceeding our senses cease to observe the increase of temperature due to them. From this it is reasonable to expect that if we could alter the rate of interaction in the reverse direction, we might arrive at a new set of phenomena due to the intensity of heat developed by the increased rapidity of combination.

It can readily be proved that when organic substances containing hydrogen undergo decay, some of the hydrogen present unites with the oxygen of the air to form water, and the heat generated by the combination is spread over so long a period that at no moment of time is it perceptible to the senses. If, however, hydrogen gas is confined under pressure in a gas-holder, and allowed to escape through a jet into the air, on being ignited it burns with an intensely hot flame, the heat energy of which can be converted by suitable contrivances into other forms of energy, such as mechanical work. In this case as much hydrogen is converted into water in the course of a minute as would have been formed in some years by the process of slow combustion, and the increase in calorific intensity obtained is solely due to the increased rate of combination, the total thermal value of the hydrogen being the same, whether it is burnt by a slow process or a rapid one.

If we now burn the jet of hydrogen from the oxyhydrogen blowpipe and urge on combustion by feeding the flame with a stream of oxygen blown into its centre, we still further hasten the combustion by saving the time necessary for the hydrogen to seek out the oxygen molecules from the diluting nitrogen of the air, and the result is an increase in temperature which gives us one of the hottest known flames.

If, instead of doing this, we supply a rapid stream of air to the outside of a hydrogen flame, we find that the combustion becomes irregular, and nnder certain conditions sound is emitted, as in the so-called singing flame, whilst if hydrogen be mixed with sufficient air to supply it with the oxygen to convert it into water, and if a light be applied to the mixture, the molecules of hydrogen being side by side with the oxygen necessary for their conversion into water, combustion takes place with enormous rapidity, and the intense heat generated expands the vapour formed to such an extent that an explosion results, whilst this result may be still further accentuated by increasing the rapidity of combustion by using pure oxygen in the right proportion to mix with the hydrogen. It is evident, therefore, that explosion may result from intensely rapid chemical combination.

As we investigate the actions which lead to explosion, we soon find that in many cases increasing the rapidity of chemical action does not bring about this phenomenon, if the products of the action only occupy the same or a smaller space than the original substance, unless they can for a moment be largely expanded by the heat developed by the action.

True explosion must, therefore, be looked upon as intensely rapid chemical action giving rise to gases or vapours which, being largely expanded at the moment of their formation by the heat developed during their action, occupy an enormously larger volume than the original substance.

The force of an explosion is due to the pressure which the gaseous products exert upon any confining envelope, and this is dependent upon the volume of gases evolved, and the amount of heat liberated and able to act in expanding them, whilst the destructive effect is, as a rule, largely dependent upon the time taken in their formation.

The smaller the space into which the original explosive can be packed, the greater will be the effect produced; a mixture of air and hydrogen explodes, but the explosion is much more violent if the same quantity of hydrogen is mixed with pure oxygen instead of air, as the retarding influence of the nitrogen is removed, and the mixture occupies less than one-half of the space occupied by the air and hydrogen.

The explosion of a mixture of hydrogen and oxygen produces a pressure of 240 lbs. on the square inch, which is very small as compared with gunpowder, which gives on explosion a pressure of 40 tons on the square inch, this being due to the fact that the ingredients of the powder are solid, and therefore occupy the mimimum amount of space; if the mixture of hydrogen and oxygen were compressed to the same density as gunpowder, it would develop on firing a pressure of over 300 tons on the square inch.

Oxygen is necessary for all the ordinary forms of combustion, but oxygen could not be used in the gaseous condition in explosives, as it would occupy too large a space; there are, however, certain compounds rich in oxygen, which hold it in such feeble combination and are so ready to give it up to bodies capable of being oxidised, that they can be used as a form of compressed oxygen, and by their decomposition they supply to the combustibles present in the explosive the oxygen necessary to convert them into large volumes of gases.

It is of great importance that the combustible and the supporter of combustion in an explosive mixture should be in as fine a state of division as possible and well mixed, so that at the moment of explosion each molecule of combustible shall find itself side by side with the molecules with which it is to combine, and that as little inactive material as possible should be present. The important effect of these conditions may be shown by taking four small pieces of phosphorus of equal size, and placing one on a saucer, when it will enter into slow combustion with the oxygen of the air, and if the day be warm, the temperature may rise to the point necessary for rapid combustion; but, if not, many hours will have elapsed before the action is complete, and the last of the phosphorus oxidised. The second piece can be ignited in a deflagrating spoon, and immersed in a bell jar of air, when it will burn away in a few minutes with evolution of heat and light; whilst if the third piece be now ignited in the same way, and plunged into a jar of pure oxygen, it will burn away still more rapidly, and the increase in calorific intensity is shown by the bright light produced.

If now the fourth piece of phosphorus be dissolved in a few drops of bisulphide of carbon, and this solution be poured upon a small heap of powdered potassic chlorate, placed on a piece of blotting-paper supported on the ring of a retort stand, the bisulphide will evaporate and will leave the phosphorus in a very finely divided condition on the surface of the chlorate, a violent explosion ensuing, this being brought about by the spontaneous ignition of some of the finely divided phosphorus which causes the chlorate to decompose, and intensely rapid combination of the remaining phosphorus with the liberated oxygen takes place. This is decomposition, which evolves heat, and the heat so generated, together with the heat produced by the combination of the phosphorus and oxygen, gives great calorific intensity on account of the rapidity of the action, causing enormous expansion, and consequent violence of explosion. The intense rapidity of combustion was in this case due to the fineness of division of the phosphorus, and to the small bulk into which the oxygen was compressed, the chlorate necessary to burn the phosphorus only occupying roughly $\frac{1}{600}$th of the volume of gaseous oxygen necessary, or $\frac{1}{3000}$th the volume of air.

The explosives in use may be classified into mixtures and compounds, the former class

containing the combustible, and the oxygen supplying substance in the condition of intimate mechanical mixture, whilst the latter class consists of organic compounds, containing oxygen loosely held in combination by nitrogen, the oxygen on any disturbance of the molecular structure of the compound entering into new combinations with the carbon and hydrogen already present in the molecule. In some of the new explosives these two classes are combined, and the gas-generating power of the second class is augmented by the admixture of highly oxidising substances, which tend to render the combustion more complete, and so increase the amount of heat generated.

Gunpowder, which is the most important and most commonly used of the explosives, is an example of the first class, being an intimate mixture of potassic nitrate or saltpetre (which supplies the oxygen), sulphur, and charcoal. English black service powder has the average composition—

Potassic nitrate	75
Charcoal	15
Sulphur	10
	100

Although in some of the new slow-burning prismatic powders the per-centages of potassic nitrate and charcoal have been increased, and less sulphur used, the service powders of various foreign Governments approximate closely to this composition.

Country.	Potassic Nitrate.	Charcoal.	Sulphur.
England — Black powders	75	15	10
England — Brown „	79	18	3
Sweden	75	15	10
Russia	75	15	10
Prussia	74	16	10
Saxony	74	16	10
United States	76	14	10
Austria	75·5	14·5	10
France	75	12·5	12·5
Belgium	75	12·5	12·5
Germany	76	14	10

The value of a powder is to a great extent dependent upon the purity of its constituents and the processes by which it is mixed, as well as on the form in which it is finally made up, and in the manufacture of service powder all these points must receive the greatest attention. Discovered and used long before the Christian era, gunpowder has undergone but few changes in composition, and it is remarkable that these changes have been restricted to comparatively short periods; the first of which may be taken as comprising the 15th century, whilst the second and most important has occurred during the past 30 years.

Invented according to tradition by the Chinese, and rediscovered, probably independently, by Roger Bacon in 1267, and by Berthold Schwartz in 1320, we have ample proof of its being used for warlike purposes at the Battle of Crecy in 1346, but it was not until the last years of the 14th century that any improvement was made in the proportions in which the ingredients were present. Up to that time, the carbon, sulphur, and saltpetre had been blended in practically equal proportions, but at the end of the 14th century a gradual increase in the quantity of saltpetre used began to be observable, and the writings of the Italian Tartaglia showed us that before 1537 the proportions of the ingredients had been improved until they closely approximated to the composition of the ordinary powders of to-day.

Simultaneously with improvements in the composition of the powder attempts were made to improve its mechanical condition, and undoubtedly the most important of these consisted in converting the finely powdered and mixed constituents, which were known by the name of meal powder, into grains which would be more convenient for handling and which at the same time, by opposing less resistance to the passage of the flame amongst the particles, increased to a great extent the rapidity of its combustion.

The earliest attempt in this direction was to sprinkle the meal powder with a spray of water which caused the fine meal to collect into small spherical masses. These were afterwards gathered together and dried, but the ease with which such grains crumbled into fine powder again prevented any important increase in the rate of combustion being attained, and it was not until the idea was adopted of compressing the meal powder into dense hard cakes and then again breaking these up into grains of the required size that any great advance in this direction was made.

These improvements having been effected, the importance of mixing the ingredients in such a way that the maximum intimacy of the mixture should be attained, began to attrac

attention, and the perfection in this direction which has been reached by the manufacture of English powder shows in marked contrast to the powders used in some Eastern countries. The most important era in the history of powder is undoubtedly to be found in the improvements and alterations made during the last three decades, during which period the combined scientific knowledge and engineering skill of those whose names will be always remembered in connection with this work, have removed gunpowder from the ranks of ordinary explosives, and have made it an absolutely reliable propellant.

The causes which led to these alterations were to be found in the new forms of guns which commenced soon after the close of the Crimean war, and with the changes from the short smooth bore cannon to the long rifled ordnance of to-day, a corresponding alteration being necessary in the rapidity with which the powder developed its propulsive force, as the sudden impulse which the grain powders employed at that time gave to the projectile in the guns then in use, would have developed strain of a dangerous character in the breech of some of the modern forms of artillery, and at the same time would have given an extremely low muzzle velocity to the projectile.

With the introduction of rifled ordnance, a change came over the science of gunnery, and an enormous increase in the size of the guns and in the charge of powder used, followed. During the Crimean War, the largest guns used were the 68 pounder smooth bore guns weighing 112 cwt. and using a charge of 18 lbs. of powder, whilst at the bombardment of Alexandria, the smallest gun used was a 6½ ton one, using a charge of 30 lbs. of powder, and at the present time 110 ton guns are being employed with a charge of 960 lbs. of powder, and it is evident that the form of the powder must be modified to keep pace with such radical alteration in the conditions under which it is to be used.

It is required of a perfect powder that when the charge is fired in the breech of the gun, the combustion shall commence comparatively slowly so as to gradually overcome the *vis inertiæ* of the projectile without throwing too great a strain on the gun, and that, as the projectile passes up the bore of the gun, the combustion shall increase in rapidity so as to supply gas more and more rapidly to increase the momentum of the shot, which should leave the muzzle of the gun with the maximum velocity. In the old fashioned grain powders this was never secured, and such powders could not have been used in the modern long bore guns, as the rapidity with which they burnt threw an enormous strain upon the breech, and would have given the maximum velocity to the projectile before it was half way up the bore of the gun, leaving friction to reduce the velocity to a considerable extent before the muzzle was reached.

The rate at which the combustion of gunpowder takes place, and at which therefore the pressure is developed, can be modified in various ways, by mechanical means. As has already been seen, the rate can be diminished by burning the powder in the form of meal, but such a method would be inadmissible in practice, as the density of the mixture is very low, the charge would occupy too large a space.

The combustion might also be retarded by reducing the intimacy with which the ingredients are mixed, but this again would be a bad and unscientific method to adopt.

The elimination of these two methods practically reduces the mechanical means for modifying the rapidity of the burning of the powder to three.

1. Varying the size and forms of the grains of powder.

2. Varying the density of the powder.

3. Varying the surface-coating of each individual grain or mass, so as to retard or accelerate the ignition.

The English Committee of 1857 was strongly of opinion that it was not right to modify the proportions in which the ingredients existed in gunpowder until they had exhausted all other devices for reducing the rate of burning, as an alteration in the proportions would sacrifice a certain amount of the total explosive force developed by a given weight of powder, and as the result of their labours, the first methods employed were of a purely mechanical nature.

The first step was to increase the size of the grains used for cannon powder at that time, and the larger grain powder gave fairly good results with the first modified forms of guns then introduced, but as the guns and charges increased in size, this powder in burning became too violent, and the next step was to produce a powder in which the grains should be uniform in shape and size.

This was done by compressing the meal powder into small moulds, so as to obtain small cylindrical pellets of about ¾ of an inch in diameter, and three-eighths of an inch in

height, with indentations at each end in order to increase the surface.

The manufacture of this powder was, however, somewhat costly, and in order to facilitate the manufacture, a powder less regular in size than the pellet powder was produced by compressing the meal powder into cakes, and then cutting these cakes again into small cubes of about five-eighths of an inch, and from these small cubes the charges of powder in the guns were built up, and later on experiments were made by increasing the size of these cubes until a large pebble powder, consisting of cubes of $1\frac{1}{2}$ inches, were arrived at.

With all these forms of powder, however, maximum rapidity of burning and evolution of gas take place at first, owing to the ignition spreading over the whole surface of the cubes, and instead of the gas coming off with more and more rapidity as the space in the gun became larger, the evolution rapidly diminished with the decrease of surface caused by the burning away of the powder.

In order to avoid this defect as far as possible, built up charges were resorted to, and it was General Rodman, of the American Service, who first tried to overcome this difficulty by building up the charge of solid slabs perforated with holes, so as to expose the minimum surface of powder at the commencement of combustion, whilst the enlarging holes produced a greater and greater surface of powder as the space behind the projectile increased. This idea has quite lately been revived, but large perforated cakes are always liable to break, and it was found far better to build up the charge of hexagonal prisms with a central core moulded in them.

It was in accordance with this idea that the black prism powder was first made, and the increase in rapidity in combustion is due first to the enlargement of the core and subsequent exposure of a larger surface, and to the fact that as the walls of the prism grow thin they break up, converting the powder during the last moments of its existence into what is practically an R.L.G. powder, thus giving enormously rapid combustion due to the exposure of a large number of fresh faces.

That this is really the case is shown by a prism being occasionally blown out with the projectile and extinguished by the sudden rush through the air, when it is seen to have been partly consumed and broken up in this way.

Side by side with these advances in the mechanical tempering of the combustion, other advances equally great in the manufacture were being made. It was realised that in order to obtain uniformity of results, absolute uniformity of ingredients, mixing, incorporation, pressure, density and degree of dryness as well as uniformity in size must be attained, and new methods were introduced into the process of manufacture with this object in view, great attention being also paid to the "finishing" of the powder prisms and the blending together of various batches of powder which presented any variation in their ballistic properties.

With the continued growth, however, in the size of the guns employed, other changes became necessary, as even when using the black prism powder for built up charges the pressure given began to throw too severe a strain upon the breech of the gun, even when the cartridges were made up in such a way as to leave air spaces at the seat of the charge in order to relieve as far as possible the initial pressure.

In order to secure further modifications in the pressure developed, it soon became manifest that chemical alterations in the composition of the powder would be necessary. Sir Frederick Abel and Sir Andrew Noble had already made researches which conclusively showed that advantages might be secured in powder to be used in heavy guns by increasing the proportion of carbon and reducing the quantity of sulphur present, when Mr. Heidmann and Mr. Duttenhofer almost simultaneously produced a prismatic powder, in which the saltpetre was increased in quantity, the sulphur reduced, and low burnt charcoal in larger proportion were employed. This powder, which received the name of "Cocoa powder," from the brown colour imparted to it by the semi-charred woody fibre, gave a considerably lower initial strain and a much longer sustained action when used in large guns.

In these powders not only did the change in the proportions of the ingredients effect a considerable alteration in their point of ignition, and rate of combustion, but the introduction of charcoal produced at a comparatively low temperature also brought into play other important considerations.

The charcoal used in making powder was at one time looked upon as being practically pure carbon, but it also contains certain proportions of hydrogen and oxygen remaining from the woody fibre from which it is formed, and it moreover has the property of absorbin oxygen and moisture with considerable rapidity

from the air, and the parts which these substances play in the explosion of the powder are only now beginning to be thoroughly understood.

The amount of hydrogen present in charcoal exerts an important influence upon the ease with which it can be ignited, but the presence of hydrogen and oxygen also reduces its thermal value, so that although the value of pure carbon is equivalent to 8,080 thermal units, the thermal value of the charcoal used for powder making rarely exceeds 6,600.

Where it is important to retain a certain proportion of moisture in powder, low burnt charcoal is of the greatest value, and the straw carbonised by superheated steam, which was used in the cocoa powder, played a most important part in imparting to the densely pressed prisms sufficient hydroscopic power to enable it to hold the necessary per-centage of moisture.

The introduction of the cocoa powder was a great advance, but with the heaviest guns it became necessary to obtain even slower combustion, and by slight modifications in composition, the present service powders known as S.B.C. and E.X.E. prism were introduced.

The E.X.E. is used in the 6-inch breech loading and R.M.L. guns, whilst the S.B.C. is employed in the 68 and 110 ton guns.

The E.X.E. prism is distinguished by its slate colour and by a groove moulded round the core, whilst the S.B.C. prism is recognisable by its brown colour and by a circular indentation round the core.

In making the new prism powders the ingredients are first accurately weighed out, allowance being made for the moisture present in the refined saltpetre, and are then mixed in charges of from 50 to 60 pounds in a revolving gun metal drum, which contains arms revolving in an opposite direction to the drum itself. The mixture is then passed through a coarse copper sieve to make sure that no solid foreign material is present, and is then called "green charge." This is now taken to the incorporating mill, which consists of two iron or stone edge runners weighing from three to four tons, which revolve on a bed made of the same material as the runners themselves, and having a sloping rim. The runners are worked by machinery from below, and make seven to eight revolutions per minute.

The green charge is placed on the bed of the mill, and is moistened with a very small quantity of distilled water, to prevent any of the charge escaping as dust, and also to aid the incorporation.

The green charge is milled for from three to eight hours according to the nature of the powder, and a workman constantly pushes the charge from the outside to the middle of the bed plate with a wooden "shover," so as to keep it under the runners.

The incorporating mills are in a long building containing six mills, each of which is shut off from the next by a partition, whilst over each mill is an iron cistern connected by a lever arm to a large wooden shutter which is exactly over the bed of the mill; explosion of the charge would raise the shutter and deluge the mill by upsetting the tank. All the tanks work on one shaft, so that the upsetting of one would drown the charges in all the mills.

The mixture, which is now called mill-cake, is next conveyed to the breaking-down machine, where the mill-cake is placed in a hopper, and is carried by an endless band to the top of the machine and then falls between a pair of grooved rollers and afterwards between plain rollers, which break it into what is termed "meal." This meal is now packed in layers in the press-box, and is subjected to a pressure of 70 tons on the square foot for about fifteen minutes, which renders it exceedingly hard and compact, and in this condition it is called "press-cake." This is granulated by making it pass through successive pairs of groved gun-metal rollers, which reduce it to the required size.

The prisms are now made by taking the granulated press-cake and compressing it in a hydraulic press machine into regular six-sided prisms. These prisms are made under enormous hydraulic pressure in phosphor-bronze moulds, and are perforated by a hole through the centre, so that when built up in the cartridge the flame can have free access from end to end of the whole charge.

Great attention is paid to the stoving of the new forms of prism powder—E.X.E. and S.B.C. —as the amount of moisture in them has an important bearing upon their rate of explosion, and they are dried first for 24 hours at 32° C., and then for 12 hours at 60° C., which leaves them with from 1·7 to 2·2 per cent. of moisture, which is the normal amount which these powders retain under ordinary atmospheric conditions.

A day's production at the Royal Government Factory represents about 100 barrels or 10,000 lbs. of powder, and it is essential that this large quantity should be as nearly as

possible uniform in itself, so that when fired in charges the results both as to muzzle velocity and pressure should only vary within extremely narrow limits.

The 10,000 lbs. of powder, however, are made in many machines, and it is manifest that not only atmospheric conditions, but also slight differences in the methods of work employed by the different men tending the machines, will make considerable differences in the batches turned out by each machine, and, if unadjusted, the batches of powder would of necessity give irregular results when used in guns.

In order to overcome this the batches of powder are blended, that is to say, the results obtained by firing a charge or charges from each batch are carefully noted, and the prisms from each batch are then mixed in such proportions as to give uniformity in the results obtained from the whole output.

The pressure exerted in the breech of a gun during the explosion is measured by a contrivance called a "crusher gauge," which consists of a steel cylinder into which a collar screws gas tight, and carries a steel piston also rendered air-tight by a gas check. A small piece of copper, which has been compressed to a known density by exposing it to a hydraulic pressure of 12 tons, and which is 0·5 of an inch in length, is placed in the bottom of the steel cylinder, the piston is then put in its place, the collar screwed up, the gas check fitted, and the crusher gauge placed in the base of the cartridge, the solid end of the cylinder being against the end of the gun, and the gas check towards the projectile. On firing the gun the gauge is subjected to the full pressure developed by the explosion of the powder, which forces the steel piston down upon the copper cylinder and compresses it. The crusher gauge having no powder behind it, is left after the explosion in the breech of the gun, and is opened, the length of the copper being accurately measured on a micrometer scale, the amount of compression indicating the pressure in the breech of the gun. Used in this way, the crusher gauge gives very reliable results, but it has been shown that when inserted in the wall of the gun, certain waves of pressure and difficulties of adjustment occasionally interfere with the results obtained.

The muzzle velocity of the shot is determined by means of the chronograph. Two screens are arranged, one about 120 feet from the muzzle of the gun, and the second 120 feet beyond the first. These screens consist of wooden frames strung with fine copper wire, the disruption of a single strand of which is sufficient to break the flow of the galvanic current. In the Boulenge chronograph, a current from a battery of eight Bunsen cells flows through these wires and back to the instrument house, where the wire from each frame is coiled round a separate soft iron core, and converts it into an electro-magnet, each of which attracts and holds a rod of steel. The electro-magnet in connection with the second frame is fixed at a lower level than the electro-magnet connected with the first, and carries a short rod with a weight at the bottom, whilst the first magnet is at a much higher level, and carries a longer rod. The current being allowed to pass through both electro-magnets, the rods are suspended in position. By pressing a key both circuits can be simultaneously broken, with the result that both the rods are liberated, and drop down guide tubes; the short rod strikes a catch, and causes a knife edge to be brought against the longer falling iron, and to make a nick in it. When both rods are liberated simultaneously, this nick occurs at a definite place. The current is then allowed to pass, the rods hung on the electro-magnets, and the gun containing the charge, the power of which is to be tested, is fired, the projectile passing through the screens and breaking the current by cutting the wires. Under these conditions the long rod is liberated a fraction of a second sooner than the shorter rod, the result being that the nick of the knife blade is no longer in the original place. By measuring the distance between the two nicks, and knowing the length of time to which this is equivalent, allowance being made for the time taken in liberating the knife blade, &c., the interval of time which elapses whilst the projectile is passing between the screens can be calculated, and, being corrected for the distance of the first screen from the muzzle, gives the muzzle velocity of the projectile.

Each batch of powder made is tested in this way, and the batches are then blended according to the results they have given, so as to obtain a powder best suited to the work required of it.

The best proof that can be deduced to show that the pressure gauge, when used in this way in the breech of the gun, gives reliable results, is that an expert operator can from the pressure recorded predict within a few feet per second what the muzzle velocity as recorded by the chronograph will be.

The uniformity of composition obtained in the Waltham processes as described may be inferred from the following Tables of tests made on various batches of E.X.E. and S.B.C. powder, which show the very small variations in muzzle velocity and pressure given by these powders.

LOT 54 E.X.E.

Charge.	Muzzle Velocity. Feet per second.	Pressure. Tons per square inch.
48 lbs.	1,981	16·8
	1,978	16·6
	1,982	16·45
	1,977	16·4
	1,980	16·55
	Mean 1,980	16·58

LOT 36 S.B.C.

Charge.	Muzzle Velocity. Feet per second.	Pressure. Tons per square inch.
360 lbs.	2,020	14·75
	2,020	14·85
	2,025	14·80
	Mean 2,022	14·80

It must, however, be clearly borne in mind that this uniformity of velocity and pressure can only be obtained by absolute uniformity in density and composition of the powder, and that in order that these prism powders should yield the above results it is essential that they should contain from 1·7 to 2·2 per cent. of moisture. This shows the great importance of keeping the powder magazines of a ship as cool as possible, as the hygroscopic character of the straw charcoal burnt at a low temperature will enable the new prism powders to retain the proper amount of moisture under all normal atmospheric conditions, but when exposed to the high temperatures often observed in ill-ventilated magazines on board ship, situated near the boilers or engines, they must of necessity lose a certain amount of water, and abnormal pressures obtained from badly kept powders are the result.

The serious effect which driving out the moisture has upon the pressure developed in the gun on firing is well shown in the following Table:—

Per-centage of moisture in powder.	Pressure in Tons per square inch.	Muzzle velocity in feet per sec.
1·5	10·75	1,497
1·0	20·18	1,523
0 7	22·02	1,545

On some of our new battle ships the magazines must from their position become overheated, and this will prove even a more serious question with the new smokeless powder than it is now with the E.X.E. and S.B.C. powders, but the trouble could easily be overcome by surrounding the magazine with a double water-tight bulk head, through which sea water could readily be made to circulate. As the temperature of the ocean only varies to a small extent, a fairly constant temperature could be maintained in the magazine, and at the same time greater safety ensured.

Great attention is also paid to the density of these powders, any decrease in density tending to increase the pressure.

Density.	Velocity. Feet per second.	Pressure. Tons per sq. inch.
1·790	2,066	17·5
1·800	1,944	14·6
1·820	1,894	12·7

The way in which powder burns is influenced to a great extent by the conditions under which it is ignited; if some powder is placed in a cylinder and touched with a hot wire, it catches fire and burns with a "puff," but if the powder is heated in a test tube at a certain temperature, it explodes. In the one case the combustion spreads from grain to grain, whilst in the second case the whole mass is heated to a high temperature, and the increase in rapidity in burning is manifested by explosion. Variation in pressure has a considerable influence upon the rate at which powder will burn, as under low pressure the flame from the powder escapes so rapidly that its power of passing on the combustion from grain to grain becomes seriously impaired.

Up to 1856, the chemical changes taking place when gunpowder was fired were generally expressed by an equation more remarkable for its simplicity than its correctness. This equa-

tion the researches of Bunsen and Schischkoff in 1857 showed to be untenable.

In 1875 and 1880, Noble and Abel published their valuable researches upon explosives, from the results of which they came to the conclusion that the same description of powder exploded several times in succession will yield the products of combustion in proportions which vary in each experiment, and that therefore the metamorphosis of gunpowder cannot be represented by a chemical equation.

This view was criticised by Dr. H. Debus, who in the Bakerian lecture to the Royal Society in 1882 showed that the chemical reactions taking place during the combustion of gunpowder are in the first place very simple, the oxygen of the potassic nitrate converting the carbon into carbon monoxide (CO) and carbon dioxide (CO_2), whilst the nitrogen is liberated; the potassium unites partly with carbon dioxide and oxygen to form potassic carbonate K_2CO_3, and partly with sulphur and oxygen to form potassic sulphate K_2SO_4, and the following might be taken as the simplest equation representing this principal reaction:—

$$\underset{\text{Potassic Nitrate.}}{4KNO_3} + \underset{\text{Charcoal.}}{4C} + \underset{\text{Sulphur.}}{S}$$

$$= \underset{\text{Potassic Carbonate.}}{K_2CO_3} \; \underset{\text{Potassic Sulphate.}}{K_2SO_4} + \underset{\text{Carbonic Acid.}}{2CO_2} + \underset{\text{Carbonic Oxide.}}{CO} = \underset{\text{Nitrogen.}}{2N_2}$$

but this equation does not even approximately represent the proportions in which the ingredients are present in powder, the ordinary service powders having the molecular proportion $16KNO_3 + 21C + 6S$ whilst the products of combustion vary with every change in the methods of burning, also with the pressure under which the combustion takes place. Probably also the size of the charge used exercises an influence on the products.

Moreover, the powder contains moisture and the carbon contains hydrogen and oxygen condensed in its pores, and the hydrogen from both these sources plays an important part in the reaction taking place in the breech of a gun, so that to represent the chemical changes taking place by an equation with any degree of accuracy is an absolute impossibility.

It is probable from the researches of Bunsen and Schischkoff, Linck, Karolyi, Noble and Abel, that during the combustion of gunpowder in the breech of a gun two distinct stages may be traced.

The first reaction is a process of oxidation occupying a very short space of time and constituting the explosion, during which as in the previous equation, potassic sulphate, potassic carbonate, carbon dioxide, and traces of monoxide, together with nitrogen, are formed. The proportions in which the original ingredients are present, and the proportions of the resulting products showing that the equation must be taken as:—

$$16KNO_3 + 13C + 5S$$
$$= 3K_2CO_3 + 5K_2SO_4 + 9CO_2 + CO + 8N_2$$

whilst some carbon and sulphur are left unacted upon, and these in the second stage of the action, which goes on whilst the products of the first stage are under great pressure, and at a very high temperature, partly reduce the potassic carbonate and potassic sulphate, with formation of more carbon dioxide and potassic disulphide according to the equation: –

$$4K_2CO_3 + 7S = K_2SO_4 + 3K_2S_2 + 4CO_2$$
$$4K_2SO_4 + 7C = 2K_2CO_3 + 2K_2S_2 + 5CO_2$$

During the combustion of the powder also a small quantity of the sulphur present unites with the metal of the gun, and some also with both the hydrogen occluded by the charcoal and that liberated by the decomposition of the moisture present in the powder, giving small traces of sulpuretted hydrogen gas, and deducting an atom of sulphur from the equation in order to allow for this secondary action, it is found that the final combustion of the ordinary service powder can be approximately represented by the equation:—

$$\underset{\text{Potassic Nitrate.}}{16KNO_3} + \underset{\text{Charcoal.}}{21C} + \underset{\text{Sulphur}}{5S}$$

$$= \underset{\text{Potassic Carbonate.}}{5K_2CO_3} + \underset{\text{Potassic Sulphate.}}{K_2SO_4} + \underset{\text{Potassic Sulphide.}}{2K_2S_2} + \underset{\text{Carbonic Acid.}}{13CO_2} + \underset{\text{Carbonic Oxide.}}{3CO}$$
$$\underset{\text{Nitrogen.}}{8N_2}$$

Using this equation, the volume of gas generated by one gramme of the powder can be readily calculated.

			Grammes.
Saltpetre....	$16KNO_2$	$= 16 \times 101 =$	1,616
Carbon	21C	$= 21 \times 12 =$	252
Sulphur	5S	$= 5 \times 32 =$	160
			2,028

The gaseous products of the combustion are:—

		Litres.	Cubic Centimetres
Carbon dioxide	$= 13CO_2$	13 (22·36)	= 290·680
Carbon monoxide	= 3CO	3 (22·36)	= 67·080
Nitrogen	$= 8N_2$	8 (22·36)	= 178·880

2,028 grammes of powder therefore yield, according to this equation, 536,640 cubic centimetres of gas, measured at 0° C. and 760 mm. pressure, or one gramme of the powder yields 264·6 cc. of gas. The mean of the results experimentally obtained by Captain Noble and Sir Frederick Abel for pebble R.L.G. and F.G. powders is, under these conditions, 263·74 cc. of gas, a quantity which, considering the risk of experimental error and slight unavoidable inaccuracies, agrees wonderfully closely with the calculated result.

The volume of the gas being measured at 0° C. and 760 mm. pressure, it is evident that at the moment of explosion the high temperature attained will expand it to an enormously larger volume.

Noble and Abel found, as the mean of a number of experiments, that one gramme of powder during combustion gave off enough heat to raise 714·5 grammes of water from 0° C. to 1° C., that is, gave out 714·5 thermal units, whilst Dr. Debus calculated that the heat generated by the reactions between the saltpetre, sulphur, and charcoal in one gramme of English service powder is 660 thermal units, but the difference would be much smaller if the amount of heat produced by the action of the sulphur upon the iron of the apparatus were known and could be substracted from the experimental number.

Noble gives the composition of the residue and gases formed during the combustion of cocoa powder under pressure as :—

SOLID RESIDUE.

Potassium carbonate	64·12
Potassium bicarbonate	13·55
Potassium sulphide	none
Potassium sulphate	22·33
	100·00

GASES.

Carbon dioxide	51·30
Carbon monoxide	3·42
Hydrogen	3·26
Marsh gas	0·31
Nitrogen	41·71
	100·00

giving at standard temperature and pressure 195 litres of permanent gases and 837 units of heat for each kilogramme of powder fired.

The large quantity of water vapour, however, formed during the combustion of the cocoa powder, makes the volume of gas at the moment of explosion practically the same as in the case of black pebble powder.

One kilogramme of powder gives at standard temperature and pressure—

	Black.	Cocoa.
Permanent gas litres	295·7	195·4
Water vapour	40·9	122·5
	316·6	317·9

When fired under ordinary atmospheric pressure, the products of combustion are very different, large quantities of potassic nitrite being left undecomposed. By lowering the per-centage of sulphur in the powder the rate of combustion is made slower, and at the same time a decrease in the volume of permanent gases, and an increase in the heat units evolved follows.

In 1891, Dr. Debus published a very valuable paper in which he shows that all gunpowder of rational composition may be regarded as being built up of three elementary mixtures :—

1.—$4\,KNO_3 + 5\,C$ called P
2.—$2\,KNO_3 + 1\,C + S$,, Q
3.—$2\,KNO_3 + 3\,C + 2\,S$,, R

and the properties of the powder vary with the proportion in which the three are present.

English black powder, for instance, may be represented as :—

$$2\,P \quad 1\,Q \quad 3\,R$$

$$\begin{aligned} 2\,P &= 8\,KNO_3 + 10\,C \\ 1\,Q &= 2\,KNO_3 + 1\,C + 1\,S \\ 3\,R &= 6\,KNO_3 + 9\,C + 6\,S \\ \hline & \;\; 16\,KNO_3 + 20\,C + 7\,S \end{aligned}$$

On analysing this powder it is found that the proportions are by experiment

$$16\,KNO_3 + 21{\cdot}2\,C + 6{\cdot}8\,S$$

which, considering that powder is a mechanical mixture, is in close accordance with the theory. In the same way—

French powder	$= 2\,P + 5\,Q + 4\,R$
,, rifle	$= 2\,P + 2\,Q + 3\,R$
Prussian powder	$= 2\,P + 3\,R$
Cocoa	$= 2\,P + 1\,Q$

These mixtures differ from one another in their properties, as P develops the greatest energy; Q develops the greatest heat; R develops the largest volume of gas. The amount of gas evolved by R is nearly double that given off by Q, while the heat evolved by R is only half that given by Q, so that in actual energy Q and R are nearly equal. In practice, however, it is of great importance in which form the energy is supplied. One

gramme of Q gives nearly the same amount of energy as one gramme of R, but the action would be very different, as Q produces more heat energy and R more gas energy. The result of this is that the action of Q is more that of a blow, whilst R yields a steady pressure.

Knowing these factors, the composition of a powder can be arranged for in the work which it has to do. Artillery powders would consist chiefly of mixtures of Q and R, varying in proportion according to the size of the gun. Rifle powder and sporting powder would be rich in Q, whilst P being nearly 29 per cent. stronger than Q or R, would increase the strength of the mixtures of which it formed part.

Miscellaneous.

THE EUCALYPTUS TREE IN SOUTHERN FRANCE.

It is said that there are no less than 150 varieties to be found in the native home of the eucalyptus. Among the best and most useful of the varieties which are known are the "colossus" or "giganticus," enormous trees, said to reach the height of from 300 to 350 feet, with diameter proportionately large. Another most useful variety is the "resinefer," which furnishes, for medicinal purposes, the "kino," or "rhatany," a valuable astringent. The *alpina*, *rostrata*, *amygdalina*, *coriacea*, *globulus*, *gunni*, *piperita*, and *polyanthemus* are the best known of the other varieties. The native home of these trees is Australia and the Indian Archipelago; but within the past 20 years the remarkable properties and qualities of the eucalyptus have attracted the attention of the world, and it is now to be found in largely increasing forests and plantations in the Argentine Republic, Southern France, and Algiers. The eucalyptus seems destined to revolutionise sylviculture in the countries mentioned, not only on account of the many remarkable properties of the tree—its resins, wood, and its rapid growth—but also its great power of absorbing enormous quantities of water from wet and swampy lands, drying them, and rendering them fit for cultivation, as well as its tendency to thus eliminate malarial conditions from the land where it grows. The United States Consul at Nice says that the eucalyptus grows with wonderful rapidity, developing within three or four years into a large tree. One, within his immediate neighbourhood, planted less than four years ago as a small shoot about the size of a man's thumb, is more than 30 feet high, after having been constantly kept trimmed down, and nearly one foot in diameter. Trees of great size in this part of France are said to be less than 20 years old. In Southern France the eucalyptus has been planted with remarkable results, and is now fully appreciated for its various qualities. In the Alpes Maritimes it seems especially to flourish. The most remarkable species is the one found in Southern France, in the neighbourhood of Nice, Cannes, Toulon, Marseilles, and various other localities, where there are now large plantations of these trees of great size, and where they prosper wonderfully, and grow with a rapidity which seems almost incredible, forests of large trees being the growth of seven or eight years. This species is known as the *Eucalyptus globulus* or "blue gum-tree," or "fever tree." This tree is now completely naturalised in Algeria and in the Riviera. A remarkable specimen of the eucalyptus is near the United States Consular Office on the Place Masséna. It is a tree of great size with enormous branches giving widespread shade, and having the appearance of great age, though in reality it is a newcomer to Nice. It sheds a resinous and pleasant fragrance, indicative of its medicinal properties. So attached are the people of Nice to this tree, that when it was proposed to cut it down to enlarge the street leading into the Quai Masséna, there was a general protest against so doing, and upon a vote being taken by one of the French newspapers there was an overwhelming majority against its removal. This tree belongs to the Australian species called "colossus" or "giganticus," and is said to be one of the largest on the coast of Southern France. To illustrate the firm hold which this tree and its health-giving properties have upon the public mind in the department of the Alpes Maritimes, Consul Hall says that when these trees are trimmed in the early spring in the Jardin Public, in the gardens of private villas and in the streets, the branches are eagerly sought by all classes of people, who hang them with their cones on the walls of their bedrooms, with the view of keeping off fevers, and of getting rid of moths, mosquitoes, and other insects. Many persons make rosaries of the burrs, and strings of beads, which they wear round their necks. The "globulus," or "blue gum tree" does not require much moisture.; in fact, it grows in dry soils, and in sandy or clayey soils, provided they are cool. It will grow only in hot houses in the climate of Paris, and will not bear great cold. The *amygdalina* is known as the "peppermint tree." It grows to a considerable height, and is the only species which bears the full winter climate in the northern part of Italy, and in the open air. The *rostrata*, or red gum tree, has many qualities in common with the globulus, but it grows better than the latter in wet and marshy lands. The "gigantea," or "giganticus," has a stringy bark. It was unknown in Europe before 1856, when Mr. Ramel sent some seeds to France which were sown in Algeria, and the Mediterranean regions. There are now forests and plantations of these trees

in the various countries of Southern Europe, Africa, &c. While this tree is strong and hardy, it is not thought that it would flourish where the thermometer indicates a lower degree than freezing point.

Correspondence.

ANCIENT SYSTEM OF MANUFACTURING SALT IN MEXICO.

With reference to the manufacture of salt, Mr. Ward, in his interesting paper, does not mention a very ancient method of manufacturing Solar salt, which is still carried on in Mexico, near a village called Ixtapa de la Sal in the State of Michoacan. The village lies at an elevation of 4,200 feet above the sea in a volcanic district, and brine is found at various points oozing from the rocks and in pits which are dug for the purpose of collecting it.

The method of evaporation is very curious and interesting; the small hills are terraced, and on the broad steps thus formed flat-topped stones or boulders, chiefly of a black close-grained volcanic rock, are carefully arranged and levelled. On the flat surface of each of these stones a small ring of clay is built up about an inch high, and in the small vessel thus formed the brine is evaporated. There are many thousands of these to be seen close to the road. The evaporation takes about four days, the little vessels being filled from time to time by men who carry the brine up from pits in the valley in large earthenware jars. The salt is of very large grain and, as might be expected, rather dirty in appearance, but the production of the district is very considerable and the method dates back to time immemorial.

I have never seen any description of this method of producing salt, and was much interested in it when I visited the district about two years ago.

James Mactear.

28, Victoria-street, Westminster, London, S.W., 19th December, 1894.

LIQUID FUEL.

Messrs. A. & C. Stewart write:—What we objected to was Mr. E. Henwood's uncalled-for statement that our arrangements were crude. He attempts to prove this in his last by our statement that one pound of oil is equal to two pounds of coal. We fail to see how this proves his assertion. Had we used a better quality of oil the result wonld have been better in proportion to the coal used, but of course the cost would have been increased, unless Mr. Henwood used the same oil. He is not in a positisn to make any comparison; and, moreover, no practical man would take the figures obtained by his experiments on such a toy as he describes the yacht *Ruby*, and put such results in comparison with those made on a practical commercial scale in a large passenger steamer developing 1,000 horse-power, and which ran for six months on the Clyde, stopping at piers about every twenty minutes.

General Notes.

Juvenile Lectures.—Professor J. A. Fleming, F.R.S., will lecture at the Royal Institution on "The Working of an Electric Current" on Tuesday, January 1st, Thursday, 3rd, and Saturday, 5th, at 3 p.m. Dr. H. R. Mill will lecture on "Holiday Geography," at the Royal Geographical Society, on Monday, December 31st, and Friday, January 4th, at 4 p.m.; and Mr. Arnold Mitchell will lecture at the London Institution on "English Cathedrals" on Monday, December 31st, and Wednesday, January 2nd.

Geographical Congress.—The sixth International Geographical Congress will be held at the Imperial Institute, South Kensington, in July and August, 1895. The programme of subjects is as follows:—I. Mathematical Geography; II. Physical Geography, including Oceanography and Geographical Distribution; III. Cartography; IV. Exploration; V. Descriptive Geography; VI. Historical Geography; VII. Applied Geography, including Anthropo-Geography; VIII. Education. An Exhibition will be held in connection with the Congress, which will include:—I. Instruments; II. Maps; III. Globes, Reliefs, Models; IV. Photographs and Pictures; V. Equipment for Travellers; VI. Historical Mementoes; VII. Publications; VIII. Collective Exhibits. A circular of information respecting the arrangements for the Congress has been printed, and can be obtained from the secretaries, at the Royal Geographical Society, 1, Savile-row, W.

French Cycle Trade.—According to statistics issued by the Ministry of Commerce, and quoted by the *Board of Trade Journal* from *Le Siècle*, the total French trade in cycles, both import and export, last year aggregated in value nearly £400,000. It is stated that one of the most interesting characteristics of last year was the decrease of the imports into France of foreign machines and the corresponding increase of the exports; whilst, in 1892, the imports into France reached 573,430 kilos., they showed a quantity, in 1893, of 394,113 kilos. *Per contra* there were exported in 1893, 150,540 kilos., in place of 119,492 kilos. in 1892.

Journal of the Society of Arts.

No. 2,198. Vol. XLIII.

FRIDAY, JANUARY 4, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

On Wednesday evening, the 2nd instant, Professor C. Vernon Boys, F.R.S., delivered the first of his course of Juvenile Lectures on "Waves and Ripples." After showing, by comparison with the pendulum, that long waves on water travel faster than short ones, the lecturer pointed out that this simple rule must fail in the case of very small waves or ripples, for no one ever saw ripples creeping stealthily along on the surface of still water.

By experiments of a simple kind, the existence of an elastic surface was clearly shown, and it was made evident that this would produce a considerable effect only in the case of ripples. The lecturer explained, by the aid of numerous experiments, the beautiful researches of Lord Rayleigh on dirty and pure water surfaces, and their bearing upon the question of ripples, concluding with an explanation of the action of oil in stilling waves in a stormy sea.

The second lecture will be delivered on Wednesday evening next, 9th inst., at 7 p.m.

Proceedings of the Society.

CANTOR LECTURES.

EXPLOSIVES AND THEIR MODERN DEVELOPMENT.

By Professor Vivian B. Lewes.

Lecture II.—Delivered November 27, 1894.

The old black powder which has played so important a part in the making of history during the last 600 years, and the modern modifications of it, to which the last lecture was devoted, is, as we have seen, an excessively intimate mechanical mixture of two combustible ingredients and a body containing oxygen, held in such loose combination that a rise in temperature is able to set it free, and render it available for the rapid oxidation of the other constituents of the powder into solid and gaseous products.

In the burning of the substances to which I wish to draw your attention to-night, we find an entirely different set of phenomena, as the compounds, gun-cotton and nitro-glycerine, differ from gunpowder in being chemical compounds, which contain within their own molecules atoms of carbon and hydrogen, which can be oxidised, and oxygen which can be rendered available for this purpose, the action being prevented in the compound by the presence of the element nitrogen, which, loosely holding the oxygen, prevents any re-arrangement of the atomic constituents of the molecule until such time as heat or a sudden jar causes a redistribution of the atoms with evolution of gaseous products.

It is manifest that in an explosive chemical compound, there being only one action to convert the solid into gas, the combustion must of necessity be more rapid than in a mechanical mixture, in which there has first to take place a breaking up of saltpetre in order to render available the oxygen, and then a combination of that with the combustibles present to evolve the gaseous products.

It was in 1832 that Braconnot, in France, observed that by acting with nitric acid upon starch he could convert it into an easily combustible body, to which he gave the name of xyloidine, whilst some six years later Pelouze noticed that when many fabrics or paper were soaked in this highly corrosive acid they underwent but little change in appearance, but had increased in weight by nearly 80 per cent., and that after all the acid had been washed out from the substance, they manifested a most extraordinary increase in the rapidity with which they were able to burn, and there is no doubt that Pelouze in this observation laid the foundation of the discovery of what is now one of our most important explosives.

It was, however, not until seven years later that the re-discovery of this interesting substance by Schönbein, in 1845, attracted much attention, and it was his proposal to use cotton wool which had been soaked in a mixture of the strongest nitric acid with sulphuric acid, and then washed and dried, as a substitute for gunpowder that drew general attention to the use of nitrated compounds as explosives. The process which Schönbein employed

he kept secret, and in August, 1846, Böttger found how to prepare this substance, and they together submitted their discovery to the German Federation, but did not make it generally public. In 1847, however, several others discovered the method of preparation, and the manufacture of gun-cotton became general.

At this time the European powers were nearly as anxious as they are now to obtain a powder which would evolve little or no smoke in its combustion, and when the discovery was made that cotton wool treated by nitric acid had the power of burning with enormous rapidity and without the formation of solid residue, Schonbein conceived that it could with great advantage be utilised as a smokeless explosive, but neither he nor any of the chemists of that period were able to make it answer their expectations in this direction, and although nearly every European power commenced experimentalising with it, it took 35 years to bring it within the range of practical utility.

Experiments were at once instituted on a large scale and its manufacture carried on in England and also on the Continent, but in 1847 a very serious explosion occurred at the works in which it was manufactured by Messrs. Hall, at Faversham, whilst a year later an even more serious explosion took place in the gun-cotton factory at Bouchet, near Paris; and, as no reason could be assigned for these and other similar explosions, gun-cotton was looked upon as too dangerous an explosive for ordinary use and its manufacture was discontinued; a result which was further borne out by the decisions of committees, which reported against gun-cotton as an explosive for use in guns. In Austria, however, General Von Lenk continued to experiment upon the causes which had led to the previous disasters and failures, and he succeeded in showing that if the gun-cotton were entirely freed from every trace of the acids used in its manufacture, it could be stored and kept with perfect safety, and it is also to the same officer that we owe many experimental facts connected with this substance.

The apparent success of the experiments in Austria attracted attention once more to the subject, and in 1862, the British Association appointed a committee to ascertain all that was known, and to inquire into the possibility of applying gun-cotton to warlike purposes. Much valuable information was obtained by this committee, with which Sir Frederick Abel was associated, and it was he who first introduced the improved processes of manufacture at present employed in the Government factory.

Cotton is one of the purest forms of cellulose, or woody fibre, $C_6H_{10}O_5$, which is one of an class of organic compounds called "alcohols" in which one of the atoms of hydrogen in water has been replaced by some group consisting of carbon and hydrogen, or carbon, hydrogen, and oxygen.

When potassic hydrate is acted upon by nitric acid, the group of atoms HO in the hydrate is replaced by the group NO_3 contained in the nitric acid, with formation of potassic nitrate and water.

$$\underset{\text{Potassic Hydrate.}}{K(HO)} + \underset{\text{Nitric Acid.}}{H(NO_3)} = \underset{\text{Potassic Nitrate.}}{K(NO)_3} + \underset{\text{Water.}}{H(HO).}$$

And in the same way when a small portion of cotton is acted upon by the strongest nitric acid, the group HO in the cellulose is replaced by the NO_3 group from the nitric acid with the simultaneous formation of water.

$$\underset{\text{Cellulose.}}{C_6H_7O_2(HO)_3} + \underset{\text{Nitric Acid.}}{3(HNO)_3} = \underset{\text{Guncotton.}}{C_6H_7O_2(NO_3)_3} + \underset{\text{Water.}}{3(H_2O)}$$

If gun-cotton were made on the large scale in this manner, the water formed during the action would dilute the nitric acid, and would give rise to an inferior kind of gun-cotton called collodion cotton, in which only two-thirds of the HO groups contained in the cellulose would be replaced by NO_3.

$$\underset{\text{Cellulose.}}{C_6H_7O_2\ (HO)_3} + \underset{\text{Nitric Acid.}}{2(HNO_3)}$$
$$= \underset{\text{Collodion Cotton.}}{C_6H_7O_2\ (HO)\ (NO_3)_2} + \underset{\text{Water.}}{2(H_2O)}$$

And in order to prevent this dilution taking place, the strongest nitric acid is mixed with $2\frac{1}{2}$ times its own volume of strong sulphuric acid, which having a strong affinity for water, absorbs it as fast as it is formed, and so maintains the nitric acid at its original strength.

Accepting the formula $C_6H_7O_2(NO_3)_3$ as representing gun-cotton, it is seen that the group NO_3 is the oxidising portion of the molecule, just as in gunpowder the NO_3 contained in the potassic nitrate KNO_3 supplied the oxygen necessary for the combustion of the charcoal and sulphur.

In the manufacture of gun-cotton, the best white cotton waste only is used, and is supplied free from all grease and dirt, which has been previously extracted by boiling it with dilute alkaline solutions; this is important, as if any greasy or resinous substances remained in the cotton, they would form compounds with the acids employed, which would be liable to cause decomposition.

The cotton is first picked over by hand, all foreign substances being removed, and it is then passed through the "teasing machine," in which rollers bearing iron teeth rotate and tear up any knots or lumps which exist in the waste; after this it is passed through the "cutting machine," which chops it into pieces not exceeding two inches in length. If any moisture were present in the waste, it would cause evolution of heat on dipping it in the acids, the cotton is therefore dried by passing it through a chamber heated to about 83° C., in which the cotton placed on endless bands travels backwards and forwards for about 20 minutes; it is then weighed up into lots of 1¼ lb., called a charge, and is placed in an air-tight box, to keep it dry until it has cooled down and is ready for dipping.

The mixture of acids consists of one part by weight of nitric acid of specific gravity 1·52 to three parts by weight or 2·45 by volume of sulphuric acid of specific gravity 1·84. These are run in the right proportions into a mixing tank fitted with a lid, through an opening in which they can be thoroughly mixed by means of a stirrer, worked backwards and forwards for some minutes. Mixing the acids is attended by evolution of a considerable amount of heat, and the mixture is allowed to stand until thoroughly cool, when it is run into a dipping-pan, a small cast-iron tank, holding about 220 lbs. of the mixed acids, and surrounded on the outside by running water, in order to guard against rise of temperature during the formation of the gun-cotton, which would tend to increase the per-centage of collodion cotton present in the finished product.

The charge of 1¼ lb. of dry cotton is now taken from its tin, and is stirred as quickly as possible into the mixed acids, in which it is allowed to remain five or six minutes, it is then lifted on to a perforated shelf at one end of the dipping-pan, and the large excess of acids squeezed out by a plate worked by a lever. The 1¼ lb. of cotton which has absorbed 14 lbs. of acids, is now transferred to an earthenware pot fitted with a cover, the pot being placed in running water to prevent any rise in temperature, and the charge remains under these conditions for upwards of 24 hours, when the excess of acids present completes the conversion of the cotton. The next step is to get rid of the free acids which are still present in quantity. To do this the contents of six pots are transferred to a centrifugal machine, consisting of a perforated iron cylinder made to rotate at a rate of 1,200 revolutions per minute, about 10 lbs. of acids being in this way separated from each charge of cotton.

The converted cotton is now placed in a cistern of water, where it is kept continually stirred in running water until it no longer tastes acid to the tongue. The gun-cotton is now again wrung out in a centrifugal machine, and is then boiled for five days in wooden tanks heated by steam coils, the water is wrung out as before, and finally the gun-cotton should be so far free from acid that it does not redden blue litmus. The gun-cotton is now reduced to pulp in a machine of the same construction as a paper-maker's "hollander," in which the fibre suspended in water is made to continually pass between a bed-plate and a roller, both being armed with knives, and after being pulped for five hours, is reduced to a very fine state of division, and then passed through a pipe into the "poaching machine. This is another large oval tank in which paddle wheels keep the pulp constantly agitated with a large volume of fresh water, which, owing to the fine state of division of the pulp, thoroughly washes every portion of it. After six hours in the poacher, samples of the pulp are tested, and if the requirements of the tests are satisfied, enough lime water, whiting, and caustic soda—sodic hydrate—are mixed within to leave between one and two per cent of free alkali in the finished gun-cotton. The pulp is now drawn up by means of a vacuum pump into an iron reservoir, called the "stuff chest," in which revolving arms keep the pulp from settling, and from which measured quantities can be run off into moulds, the bottoms being made of a very fine wire gauze, that allows the water to pass through but keeps back the fine pulp, the filtration being aided by the action of a partial vacuum maintained below the moulds.

When most of the water has been in this way separated, hydraulic pressure of about 34 lbs. on the square inch, is brought to bear upon the the semi-solid pulp, which expels a great proportion of the remaining water, and renders the blocks sufficiently hard to bear careful handling. The moulded gun-cotton is now taken to the "press-house," where it is subjected to hydraulic pressure of about five tons on the square inch, which reduces it to one third of its original bulk, making it so hard that it does not perceptibly yield to the pressure of the finger, and when dry will just sink in water.

During the process of manufacturing gun-

cotton, every precaution is taken to prevent any great rise of temperature during the period when the cotton is in contact with free acid, in order to avoid decomposition of the gun-cotton with evolution of large quantities of red fumes—oxides of nitrogen—and the formation of oxalic acid and other products, whilst even a small rise in temperature increases the proportion of collodion cotton present, and so detracts from the value of the finished product. In the second stage of the manufacture—from the removal of the superfluous acid in the centrifugal wringing machine to the moulding of the blocks, the object of all the operations is to thoroughly free the converted fibre from every trace of free acid, and it has been conclusively proved that it was to a great extent owing to the retention of free acid that the explosions which attended the early manufacture of gun-cotton were due. Cotton when examined under the microscope is seen to consist of minute tubes, which during immersion in the mixed acids become filled with them, and the last traces cannot be removed by any ordinary rinsing process such as was at first considered sufficient, and when such impure gun-cotton is packed in cases chemical action is maintained by the traces of acid present, the heat generated being confined to the centre of the mass by the non-conducting properties of the cotton surrounding it; the action increases very rapidly with the rise of temperature, and a point is soon reached at which the gun-cotton becomes ignited. The liability to spontaneous decomposition is much increased when cotton which has not been thoroughly cleaned, or which contains any fatty or resinous matter, is used, and also by the presence of a large proportion of collodion cotton, which is not so stable as the completely nitrated product.

This latter cause undoubtedly was a source of danger in the gun-cotton first manufactured. This was not left long enough in contact with the acids, so that the complete conversion of the whole of the cotton had not taken place and some less stable products were present. The finished gun-cotton is tested and the amount of alkalinity determined; the alkaline matter present should not be less than 0·5 per cent. or more than 2·0 per cent.

Having tested the finished gun cotton for alkaline matter, it is dried at a low temperature and tested for evolution of acid. This is done by taking a small portion of the finely divided substance and placing it in a test tube with a piece of test paper, moistened with a mixture of potassic iodide and starch, and then gently heating the tube in a water bath at a temperature of 66° C. No discolouration of the paper must take place for at least ten minutes. If there is any free acid present nitrous fumes will be evolved which will attack the potassic iodide, liberating iodine, which at once gives an indication by forming the blue iodide of starch.

The per-centage of collodion cotton present is next determined by treating a carefully weighed sample of the gun-cotton for some hours with a mixture of alcohol and ether, which dissolves the collodion cotton but not the fully nitrated product. When fifty grains of the gun-cotton are treated in this way for three hours, with frequent shaking, with four ounces of a mixture of two parts by volume of ether and one volume of alcohol, the loss of weight, due to collodion cotton dissolved out from it, should be very small. Unconverted cotton can be detected by treating the gun-cotton with acetic ether, which dissolves the converted but not the unconverted cotton fibre.

Gun-cotton differs very widely from gunpowder in its properties, requiring a much lower temperature for its ignition, as gunpowder has to be heated to a temperature of at least 250° C., whilst gun-cotton will often take fire at 136° C., and invariably does so below 204° C. Gun-cotton can be fired by striking it with a steel hammer on an anvil. The explosion, however, is confined to the portion struck, but it is very difficult to ignite powder in this way, The rate at which gun-cotton burns is dependent upon the mode of its ignition, and the conditions under which it is placed. A piece of loose gun-cotton, placed on the hand, and touched with a hot glass rod, burns away so rapidly that the skin is not scorched or burned. For the same reason, a piece of gun-cotton can be fired upon a small pile of gunpowder without igniting the powder, and grains of powder can indeed be wrapped up in gun-cotton and the gun-cotton ignited without the powder being burnt.

Rapid as this combustion is, however, it occupies an appreciable time, as may be seen by igniting a train of loose gun-cotton, which takes several seconds to burn a few feet, giving at the same time a large flame. If gun-cotton be confined at the moment of ignition this flame is forced back into the mass, and by rapidly heating it brings it to the point at which combustion passes into explosion, and prior to

1868, when gun-cotton was required for destructive purposes, it was always confined in strong cases, but in that year Mr. E. O. Brown, of Woolwich, discovered that when a detonating fuse was exploded in contact with compressed gun-cotton, the unconfined mass at once exploded with enormous violence, and this discovery of the possibility of detonating gun-cotton marks the second great stage in the history of the substance.

The fact that certain unstable compounds could be caused to undergo instantaneous decomposition by the sympathetic vibration set up in them by a sharp explosion, either in contact with or close to them, had been previously known, and Nobel had exploded nitroglycerine by detonation some years previously, but another new and most important fact was discovered nearly at the same time, namely, that gun-cotton, when wet, and containing 15 to 29 per cent. of water, could be detonated, and gave even better results than when dry, provided that a small portion of dry gun-cotton was placed in contact with the detonating-fuze, the explosion of this portion ensuring the detonation of the wet mass.

The great importance of this discovery is seen when one considers that the sudden conversion of the solid mass into gaseous constituents endows gun-cotton when exploded in this way, with an enormous destructive power, which is as great when the explosive is free as when it is confined, and that although it can be detonated when wet, in this condition it is not inflammable, and that a hole may be bored through a block of wet gun-cotton with a red-hot iron without inflaming it, a fact which renders it the safest explosive we possess, as it can be stored wet in closed vessels and dried as it is required for use, or even used wet with a small primer of dried gun-cotton.

The non-explosive properties of wet gun-cotton, under all ordinary conditions, were demonstrated by the Government Committee of 1871, who constructed two small magazines, and in one placed a securely-fastened tank, containing 2,240 lbs. of gun-cotton in discs, whilst in the second magazine the same amount was packed in eighty closed boxes, 28 lbs. in each; in both cases the gun-cotton contained about 30 parts of water to 100 of dry material. The remaining space in the magazines was now filled with shavings and other inflammable material, which were fired. In two hours the entire contents had burnt away, but without the slightest sign of explosion, although the heat generated was very great, as was shown by the distortion of iron bars upon which the cases had rested.

If dry compressed gun-cotton is ignited by touching it with a hot rod, it burns away with a fierce flame, but without explosion, but if larger quantities were ignited in this way, the portions first burning would quickly heat up other parts of the mass to the temperature at which combustion becomes explosively rapid, and as soon as this point was reached detonation of the whole mass would take place.

The great increase in effect gained by detonating such explosives as gun-cotton arises from the enormous increase in rapidity of explosion. A train of ordinary gun-cotton fired by a hot rod takes several seconds to burn a distance of a few feet, but if a train of compressed gun-cotton was fired by detonation, the explosion would travel at the rate of 200 miles a minute. When gun-cotton is fired by touching it with a red hot rod, its combustion occupies an appreciable time, and the gaseous products evolved have time to find space for themselves in the surrounding air. If, however, detonation be employed, the conversion of the solid into an enormously increased volume of gas takes place instantaneously, and the atmospheric pressure forms just as good a "tamping" for the gun-cotton as the strong metal cases which were employed before the principle of detonation was recognised.

In order to detonate gun-cotton, fuses charged with mercuric fulminate are now generally employed.

Several theories have been brought forward to explain the phenomena of detonation, the first being that the vibrations caused by the detonator are able to set up similar vibrations in the body detonated, and that these vibrations start a sympathetic decomposition, and determine its instantaneous resolution into the products of explosion.

When a particular note is sounded on a violin, the string of a second similar instrument will spontaneously vibrate and emit the same note, and the same synchronism of vibrations in the detonator and explosive are—according to Sir Frederick Abel's theory of detonation—the cause of the explosion.

The facts which most strongly support this view are that the detonators which will cause explosion of one compound must be varied to fit them for producing a similar result with a different explosive, and also that the detonation of a small disc of gun-cotton at one end of a tube three feet long will produce detona-

tion of a similar disc at the other end of the tube, although if the discs are in the open air, they must be placed within half-an-inch of each other for detonation to take place.

This theory assumes that the vibrations are transmitted through and by the explosive, but Berthelot contends that the explosive substance does not detonate because it transmits the movement, but because it stops it, and transforms its mechanical force into calorific energy capable of suddenly raising the temperature of the substance to a degree at which its decomposition is effected, this in turn giving rise to the reproduction of a similar shock.

This vibratory movement Berthelot regards as a complex movement of a chemical and physical order when it is going on in the explosive, whereas it is purely physical when being transmitted through a substance like air whose nature is not changed by the wave, but on impact with the explosive body the wave is propagated by reason of a series of similar shocks incessantly reproduced in the explosive material, and which as they continue, regenerate the energy throughout the wave and propagate the action with increasing velocity.

When however the shock has to be transmitted through air, the propagation is effected solely by reason of the last shock communicated to the air by the explosive, and which being no longer regenerated rapidly weakens by distance.

If Berthelot's theory be correct, the increase in velocity during detonation ought to admit of measurement by means of Nobel's chronoscope, and experiments made by Sir Frederick Abel showed that when 170 cylinders of compressed gun-cotton were placed end to end and detonated from one end of the series, the rate of detonation for the first six feet was 17,466 feet per second, and for the last six feet 17,738 feet per second, an observed increase which might well come within the limit of experimental error. It seems to me, however, that no matter how closely the cylinders were placed together, the break in continuity of the compressed cotton must tend to check the rapidity of propagation, and would therefore invalidate the results. The following analogies are suggested.

If a heavy ball be allowed to fall through the air from a height under the influence of gravity, the fall becomes more and more rapid as the distance from starting point increases, but if the ball be allowed to roll down a long flight of steps, the total vertical fall being equal to that of the previous case, each step breaking the fall, the increase in rapidity observed on the last step is but small.

The products formed during the explosion of gun-cotton vary so greatly with the conditions under which it is fired and the proportion of collodion cotton present, that any attempt to construct an equation must be misleading.

When gun-cotton is fired under ordinary atmospheric pressure, the products of combustion are found to be carbon dioxide, carbon monoxide, marsh gas, nitric acid, nitrogen, water vapour, and sometimes traces of cyanogen and hydrocyanic acid; but as the rapidity of explosion and the pressure increase, so the products become less complex. When detonated the gaseous products of the decomposition are

	Dry Gun-cotton.	Wet Gun-cotton.
Carbon dioxide	24·24	32·14
Carbon monoxide	40·50	27·12
Hydrogen	20·20	26·74
Nitrogen	14·86	14·00
Marsh Gas	0·20	None.
	100·00	100·00

Estimations of the pressure developed by the detonation of gun-cotton differ greatly in value, Berthelot placing it as high as 24,000 atmospheres, or 160 tons on the square inch, whilst other authorities estimate it as not much more than half this pressure.

The experiments of Sir Frederick Abel show that the detonation of moist gun-cotton is rather quicker than of dry, whilst the work done by the same weight of cotton appears to be equal in either case. The presence, however, of water in the moist gun-cotton must use up a certain amount of the heat, but this will be accompanied by an increase in the volume of the gases owing to the extra hydrogen liberated. It has been proposed to soak the gun-cotton in paraffin instead of water in order to get over the trouble of evaporation, and this has been tried with fairly satisfactory results, but the addition of a hydrocarbon to a substance already containing too little oxygen for its complete combustion seems hardly advisable.

In 1847, Sobrero, whilst experimenting with glycerine, found that by treating this substance with strong nitric acid he obtained a compound

which, on account of its exploding on a sudden rise of temperature, he called "pyro-glycerine;" but its value as an explosive was not realised until 1863, when Alfred Nobel showed that by firing it by detonation an excessively powerful effect could be obtained.

Glycerine or glycerol—$C_3H_8O_3$—is a sweet, syrupy liquid, having a specific gravity of 1·269 and a boiling point of 290° C., at which temperature, however, it undergoes partial decomposition. It is soluble in water and in alcohol, but it is insoluble in ether. It is contained in the liquor left after the separation of soap in the manufacture of that article, being one of the products formed when oils or fats are acted upon by alkalies, and is obtained in still larger quantities during the manufacture of palmitic acid for candle making.

The vegetable fat, palm oil, which chiefly consists of palmitin, when acted upon by superheated steam, is broken up into palmitic acid and glycerine which can afterwards be separated.

$$\underset{\text{Palmitin.}}{C_3H_5(C_{16}H_{31}O_2)_3} + \underset{\text{Steam.}}{3H_2O}$$
$$= \underset{\text{Palmitic Acid.}}{3H(C_{16}H_{31}O_2)} + \underset{\text{Glycerine.}}{C_3H_5(HO)_3}$$

When acted upon by strong nitric acid, glycerine, like cellulose, is converted into a nitrate with simultaneous formation of water—

$$C_3H_5(HO)_3 + 3(HNO_3) = C_3H_5(NO_3)_3 + 3(H_2O).$$

In the manufacture of nitroglycerine, a mixture of 992 lbs. of nitric acid, specific gravity 1·48, and 1,680 lbs. of sulphuric acid, specific gravity 1·84, is thoroughly cooled and run into the mixing vat made of chemically pure lead, all the joints of which are autogenously melted together. The glycerine is then slowly and carefully added by means of an injector which regulates the rate of supply, whilst the whole charge is kept well agitated by blowing air through it, which not only thoroughly mixes the glycerine and the acids but also prevents local heating. In this way 330 lbs. of glycerine are mixed in with the acids, the process taking about an hour, and every precaution is taken to prevent the temperature rising above a limit of 22° C. (71·6° F.), the mixture being cooled by cold water, which is run through a coil of lead pipes inside the vat. If by any chance the temperature should rise to a higher limit, a valve in the bottom of the vessel can be opened, and the whole charge run into a tank of water placed below it.

As soon as the nitrating is completed, the charge is run into a second lead tank or vat and allowed to stand for an hour, when the nitroglycerine separates and rises to the top of the mixed acids. When the separation is completed the acids are drawn off, and the nitroglycerine is run off into lead vessels, where it is first washed with water and then with a solution of soda. The washing process is then repeated three times with hot water and soda, and after separating from the wash water is filtered through table salt and run into the store tanks.

Nitroglycerine so prepared is an oily colourless liquid, which has no odour and is soluble in water, although it rapidly dissolves in ether, benzol, wood spirit, and hot alcohol, and from the solution so formed can again be precipitated on dilution with water.

It has a violent effect upon the system, acting in large doses like strychnine, whilst even traces produce vertigo, and as it is absorbed through the skin people working with it are frequently at first seriously affected, but after a time experience no ill effects and, it is said, present a more than usually healthy appearance. When cautiously heated to 100° C it slowly evaporates, at 200° C it burns, and detonates at 257° C. When a lighted match is applied to it it burns quietly away, and, when the light is removed, the flame generally goes out; indeed a lighted match may be extinguished by plunging it into nitroglycerine. It is, however, detonated by a sudden blow or by heating it to 257° C. Nitroglycerine becomes solid at 4° C, but so much depends upon the length of exposure to cold that this may happen at from +8° C to −11° C, and in this condition it is comparatively inert, hence it is necessary to thaw it before use, an operation attended with considerable risk. It is stated that exposure to the direct rays of the sun will convert it into a very unstable and explosive substance, and also that the presence of ozone will sometimes cause its spontaneous decomposition.

When nitroglycerine is exploded it is instantaneously decomposed into gaseous products, the probable decomposition being:—

$$\underset{\text{Nitro-glycerine.}}{2(C_3H_5(NO_3)_3} = \underset{\text{Carbon Dioxide.}}{6(CO_2)} + \underset{\text{Water.}}{5(H_2O)} + \underset{\text{Nitric Oxide.}}{NO} + \underset{\text{Nitrogen.}}{N_5}$$

showing that the amount of oxygen present is more than sufficient for complete combustion, which is not the case in any other explosive compound.

Nobel has found that about 1,200 times its own volume of gas, calculated at normal

temperature and pressure, is generated by the explosion of nitroglycerine; whilst the heat evolved expands it to nearly eight times this volume. Its explosive force, volume for volume, being nearly thirteen times as great as gunpowder.

The rapidity of detonation of nitroglycerine is very great, and it is this which gives rise to the downward effects noticeable in all nitroglycerine or dynamite explosions.

Six cubic inches of nitroglycerine when exploded would yield about a cubic yard of gas, and would require approximately $\frac{1}{40000}$th of a second for conversion into the gaseous form. A square yard of surface carries an atmospheric pressure of, roughly, nine tons, so that the gaseous products would have to lift nine tons to a height of one yard in $\frac{1}{40000}$th of a second, and the earth, being rigid, is broken up by the recoil from this enormous strain.

For blasting purposes nitroglycerine was at one time very extensively used; the fact of its being unaffected by moisture gave it a great advantage, whilst the rapidity of its explosion made it only necessary to prepare a bore-hole, partly fill it with nitroglycerine, and then fill up the hole with water; the water forming just as good a tamping for the nitroglycerine when fired by detonation as if the hole had been plugged with wood or metal. The use of nitroglycerine for blasting purposes is, however, attended with several inconveniences, as being fluid it can only be used in downward bore-holes, whilst its transport in the liquid form has given rise to many accidents; and, finally, the liquid state is not very suitable for detonation, as the fluid yields to the sudden blow, and is often scattered instead of being completely exploded, so reducing its power, and becoming a source of danger in subsequent operations. In order to avoid these drawbacks, Nobel made the nitroglycerine into certain plastic preparations by mixing it with various absorbent substances, and these mixtures, in many cases, have a higher explosive power than the nitroglycerine itself.

These nitroglycerine preparations to which Nobel gave the name of dynamite may be divided into two classes; first, those containing non-explosive absorbents; and, secondly, those with explosive absorbents, the majority of these will be considered under the heading of blasting explosives.

When first working in this direction, in 1866, Nobel used charcoal as an absorbent for nitroglycerine, and, encouraged by the success of his experiments, tried various other bodies which were capable of taking up and holding the nitroglycerine, and he came to the conclusion that the infusorial earth first found at Oberlohe, in Hanover, gave the most satisfactory results. This earth consisted of the remains of diatoms, and contained 95 per cent. of silica, which is so finely divided as to be free from any grit, and which after having been heated to a moderate temperature, to remove moisture and organic matter, can be ground and sifted.

This substance is called keiselguhr, and is mixed with three times its weight of nitroglycerine, the mixture being made by hand-kneading. It is sometimes squeezed by hand through the meshes of a coarse sieve, and sometimes is forced out of a metal tube by means of a peculiarly constructed Archimedean screw, the resulting mass being cut into lengths to form cartridges of the required size.

During the mixing of the substance 8 per cent. of sodic carbonate, baric sulphate, mica, talc, ochre, and ammonium carbonate, are allowed to be added to it. This substance is generally known by the name of dynamite No. 1. In the large factory at Ardeer, the keiselguhr employed comes from Aberdeenshire, and is of considerable purity, containing 98 per cent. of silica, whilst in France a similar earth, called "Randanite," is employed.

The finished dynamite is a semi-plastic substance of a reddish-brown colour, containing 75 per cent. of nitroglycerine, and has a specific gravity, as made at Ardeer, of about 1·6. Under normal conditions dynamite can be set fire to by the application of a flame, and even when in considerable quantity can be burnt in this way without explosion, but, like nitroglycerine, if the temperature rises above a certain limit, the combustion increases in rapidity until the temperature of detonation is reached.

This phenomenon of the gradually increasing of combustion and consequent increase in temperature is found in all substances capable of undergoing detonation. If a mixture of nitric oxide and carbon bisulphide be inflamed in an open-mouthed jar, not more than eight or ten inches in height, it burns quietly, emitting a most brilliant light, but if a long cylinder be employed, the flash of light is seen in the upper part of the cylinder whilst the mixture in the lower portion violently explodes. The same phenomenon may be observed when

burning mixtures of acetylene and air, as with a long tube or cylinder, containing a mixture of one volume of acetylene to three volumes of air, the combustion will often commence quietly with deposition of large volumes of carbon, but the flame rapidly becomes quicker and quicker until the last portion of the mixture detonates and generally breaks the vessel to pieces. In the case of gun-cotton also, it is well known that small quantities burn away perfectly quietly, but large masses will first burn in the ordinary way, then the temperature generated will often rise until the remainder explodes, and if a stick of gun-cotton were cast of considerable length, it would be found that although it would burn quietly at first, the combustion after a few inches had been consumed would get so rapid that it would make a screaming sound, which would quickly get shriller and shriller until explosion resulted.

Dynamite, like nitroglycerine, freezes at a temperature of about 4°C. The frozen cartridges are less sensitive to shock and detonation, and therefore have to be thawed before use for blasting purposes, and it has been found that frozen dynamite burns very slowly, the first portion of the heat being used to thaw the substance before combustion takes place, but the burning frozen dynamite cartridges are much more likely to explode than when the dynamite is in its ordinary state.

Dynamite is not so easily detonated by shock as nitroglycerine, and Berthelot states that this is due to the inert mass present having a cushioning effect upon the mechanical force of the blow, the energy imparted being divided between the absorbent and the nitroglycerine, and for the same reason the dynamite is less crushing in its action than nitroglycerine, because the heat evolved in its detonation is shared between the products of explosion and the inert body present.

Experiments made by Sir Frederick Abel gave a velocity of propagation of detonation in dynamite as 20,000 feet per second, but the experiments having been made with half-inch cartridges placed end to end in a continuous train, 42 feet in length, the break in the homogenous nature of the train may have introduced error into the result.

It is interesting to note that experiments made by General Abbott in submarine mining, show that the intensity of the action of such dynamite containing 75 per cent. of nitroglycerine, is greater than that of nitroglycerine itself, and a confirmation of this was found in the fact that Sir Frederick Abel found the rate of detonation of dynamite was much quicker than that of nitroglycerine, this, however, being to a certain extent due to the liquid particles of the latter having a tendency to escape from the blow of the detonator.

One of the great troubles with keiselguhr dynamite is that under certain conditions some of the nitroglycerine will exude from it, this being specially the case when wet or placed in water, and in 1886 Mr. Walter Reid utilised the idea of making dynamite in which low burnt charcoal made from cork rich in hydrogen is used as the absorbing material instead of keilselguhr, and the absorbing power of this charcoal is so great that a dynamite can be made containing only ten per cent. of the cork charcoal and 90 per cent. of the nitroglycerine, which is retained with such power by the absorbent nature of the inert material that it can be kept for years under water without losing its nitroglycerine, whilst the high percentage of explosive gives it a greater intensity of action than is the case with the keiselguhr dynamite.

This preparation is called carbodynamite, and the inventor claims that it can be made absolutely uninflammable by the incorporation with it of one-fourth its weight of water, which can easily be kneaded into it, and that in this state it can still be exploded by the use of a sufficiently powerful detonator.

Miscellaneous.

THE BASKET-WARE INDUSTRY OF UPPER FRANCONIA.

The United States commercial agent at Bamberg says, that nestled among the mountains of Upper Franconia, Bavaria, near the boundary line of Thuringia, is the small town of Lichtenfels, and very few of the travellers who in journeying from Munich towards Leipsic, pass this apparently insignificent place, are aware of the fact that here is situated one of the largest basket-ware markets in the world. The export from this market, both to European countries and to the United States, is of very considerable importance, and there is hardly a firm to be found dealing in this description of goods in the inland towns of Germany which does not order from Lichtenfels. The origin of the basket-ware industry in Lichtenfels dates from the close of the last century, at which period a citizen of the place undertook the business of weaving baskets on a small scale, commensurate with the modest means at his disposal. The circumstance that induced him to begin the undertaking was the

existence of a splendid growth of willow trees in the neighbouring valley of the Main, thus furnishing him with the means of material for producing the article. At first the industrious basket weaver could find a sale for only the more primitive varieties of his merchandise, but the small farmers of the neighbourhood who occupied themselves with basket weaving soon brought the art of producing baskets to such perfection that the founder of the new industry ventured to send his wares to the larger fairs and markets of the country, and even to seek additional purchases in foreign lands. In spite of the fact that equally good material for manufacturing baskets was to be found in France, the latter country continued to order the German article almost exclusively until the outbreak of the Franco-Prussian war in 1890. Even at the present day Lichtenfels, Michelau, Hirschaid, and Burgkundstadt send basket ware to the French market. The gradually increasing demands upon the young industry necessitated the securing of foreign raw material. The finer varieties of willow reeds had to be imported from Hungary and France, and even from countries beyond the sea, straw for the finer woven articles being ordered from Spain and Italy, and the palm leaves used for ornamenting the better class of wares from the tropics. In this manner the evolution of the so-called house industry in Lichtenfels proceeded, resulting in the employment to-day of about 16,000 men, women, and children, who produce every imaginable variety of articles from the simplest to the most elegant. Factories, in the ordinary acceptation of the term, are very few in number. The basket-ware manufacturer delivers the raw material to the people who are to manufacture articles therewith at their own home, that is to say he weighs out for them the willow reeds, coloured straw, palm leaves, &c., and gives them the designs, according to which the various articles are to be made, and at a stated time, generally on Saturday or Monday, the workers, who for the most part live in neighbouring villages, bring the products of their industry and skill to the manufacturer, receiving very small remuneration in return. Apart from the low rate of wages, however, the basket-ware industry receives encouragement through the schools of design that have been established and are supported by the State, in which the young people of the neighbourhood are educated in all branches of the industry. A child who has attended such a school is able, at the age of eleven or twelve years, to engage independently on basket weaving, or at least to aid the adults very materially in their labours.

THE TANNING SCHOOL OF SAXONY.

Of late years the tanning industry is said to have shown some signs of languishing in Germany, the competition with France and the United States being exceedingly keen. To remedy this, a tanning school —the only one in the world, according to the United States Consul at Chemnitz—was opened at Freiburg, in the heart of Saxony. In Austria and France there are schools in which the chemistry needed in tanneries is taught, but there is no such school as that of Frieburg. Frieburg has a population of 28,000. The school was opened in 1889, and its object is stated in its name. In it instruction is given in practical and theoretical preparation of leather, in tanning, and in finishing. It is supported by the State, which devoted to it the sum of 5,000 marks in 1893; by the city of Frieburg, which contributed 1,500 marks; and by friends, who gave it 2,385 marks. Besides money, presents of hides, rare pieces of leather, barks, nuts, &c., are sent to it, and also magazines and technical papers. Its scholars come from all parts of the world. Every year—since 1889—students from Prussia, Austria, Roumania, France, Meiningen, Russia, Holland, Switzerland, Bavaria, Oldenburg, and Saxony have been in attendance. For practical work, the school is fitted up from cellar to garret with all kinds of machinery, from the steam-engine furnishing power, to the finishing machine that turns out the finest patent, or calf-leather. There are rooms and machines for the unworked skins, lime baths, vats, and cutting, rolling, pebbling, stretching, and pressing-machines. It is stated that all the machinery used was made in the United States, and the director of the institution worked for ten years in the tanneries of that country. The students devote most of their time to studying tanning, preparing and finishing leather. They learn about oxygen, alkalis, carbo-hydrates, albumenoids, and fermentation. They study text-books and hear lectutes, in addition they work in the tannery and the laboratory. Besides the director, there is a body of chemists, and teachers, at the head of which is Dr. von Schroeder. Under these, again, is a regular corps of practical tanners, who take a hide as it leaves the animal, through lime baths to the polishing rolls and processes, watched at every stage by the students. To this work the students give at least ten hours a week—two hours daily. Hides from all parts of the world are experimented on annually, and with all kinds of tanning, barks, and materials. The processes of the old and new schools are shown and compared. The former give good, and the latter quick results; the former are expensive, the latter cheap. The processes for softening, use of lyes, lime, arsenic, &c., for removing hair, &c., are gone into most minutely by men who have a great reputation for skill in their special lines. The articles used comprise oak, pine, quebracho, mimosa, valonia, sumac, and willow barks; extracts of oak, querbacho, hemlock, and gambier. The relative value, &c., of these barks and extracts are minutely examined, compared, and noted. The old vat or vault system is compared with the newer ones, in which the tanning is done by cold batteries, extracts, steam, and baths. Practical work is done on all kinds of machines. The school has a cutting machine, with a cutting surface of eight feet

ten inches. It is stated that nothing is neglected, each department being as perfect as intelligence, skill, and money can make it. During the winter Dr. von Schrœder and others give lectures. They treat of leathers, their qualities, &c., and how to distinguish the different kinds of dyes, extracts, and barks. Added to the foregoing are trips to tanneries, to woods to see the bark growing on the trees, to storehouses to examine the different descriptions of bark with a view to buying wholesale, and to experimental stations to examine processes or tests. The studies and hours per week are as follows:—Tanning and preparation of hides and leathers, twelve hours; chemistry and physics (especially relating to tanning), ten hours; bookkeeping, two hours; commerce and exchange laws, two hours; arithmetic, two hours; correspondence, one hour; drawing, two hours; freehand drawing, one hour; and mechanics, two hours. In connection with the question of tanning, Consul Monaghan mentions a curious fact, illustrating the wise and careful economy of the German people. Packages of tobacco sent from South America come usually done up in undressed hide-boxes. These boxes are taken to the tanneries and training schools to be made up into leather. Besides being excellent illustrating material, they are stated to be the source of a considerable income to the tanning school.

THE GROWTH OF LENTILS IN FRANCE.

The lentil has been cultivated since pre-historic times in temperate Oriental countries, in the Mediterranean regions, and even in Switzerland. It is believed that it existed in a spontaneous state in Western Asia, in Greece, and in Italy, and its geographical area now includes all Europe and all temperate Asia. The United States Consul-General in Paris says, that the production of lentils in France is confined chiefly to the eastern and south-eastern departments. In the western provinces they are grown to a limited extent by farmers and used as food for their stock. There seems to be a great diversity in the habits and tastes of the people of the different sections of France as regards this vegetable. In some provinces they are almost universally used by the peasantry and the labouring people of the cities in the making of soup and porridge and for other purposes, and are regarded as a nutritious and economical food stuff. The lentil is, like all farinaceous vegetables, very nourishing, and among the peasantry in some sections the belief exists that it induces the hypersecretion of milk after parturition. Sometimes lentils are ground into flour from which bread of an inferior quality is made. In the north, lentils are said to be used to some extent in the manufacture of chocolate, cocoa, and infants' food. There are several species, viz., the common lentils, large white or rather pale green lentils, with very flat seeds of a pale blonde colour, about one-fourth of an inch in diameter; the small lentil of the same colour; and the small red lentil, the seeds of which are of a reddish colour and do not reach a larger size than about one-sixth of an inch in diameter. There is of the species last-named a spring lentil known as *lentil à la Reine*, and a species of small winter lentil. The Puy lentil, of a green colour, especially cultivated in the neighbourhood of the town of Puy-en-Velay, is plainly characterised by its small seeds and showing a green colour dotted with black. There are many differences in the culture of lentils according to the species. The common lentil is the kind more generally met with in commerce. It is especially consumed in the north, being a spring lentil which, in the central part of France, is sown as soon as the cold and frost are over. As it requires a light soil, two ploughings alternately with harrowing are sufficient to bring the earth to the required state. They are sown sometimes in "pockets," sometimes in rows. The sowing in "pockets," performed with a hoe, produces a tuft of lentils about every twelve inches. For this purpose five or six seeds are placed in holes, rather large not deep, and are covered with earth to a depth of probably two inches. The way of sowing requires a great deal of time and is very inconvenient, rendering the digging difficult, and yields only a small production. The preference is given to sowing in rows, which may be done at the same time as the last ploughing or even after harrowing. In the first place a woman follows the plough and drops the lentil seeds as regularly as possible in the rows; they sow only every other line, so as to obtain sufficient space between the rows of plants. The lentils mature about the end of July, and the returns are from twenty-eight to about forty bushels per *hectare* (2·47 acres). The small red lentil is generally used as fodder for animals, and is sown broadcast. The green, or Puy lentil, is highly thought of in the south of France; it is an important culture all over the Auvergne province. It grows at a considerable altitude. The ground is generally prepared in the autumn or during the winter even when the snow is on the ground. The United States Consular agent at Calais says, that in the north of France large quantities of lentils are cultivated for animal food, especially for horses. On almost every farm they sow in September a mixture called *hivernache*, composed of one-half of rye, one-fourth of vetches, and one-fourth of lentils. The crop is ripe in July, and in the autumn is reported to be one of the best stimulants for horses when they have the heaviest work to do. This mixture offers great advantages because the rye has grain at the top of the bunch, vetch in the middle and the lentils about a foot high give rich food at the bottom of the bunch, where the straw has rarely any nutritive qualities. Sometimes cows are fed with this *hivernache* when the meadow grasses are scarce and poor, and the milk is at once more plentiful and richer in butter.

Notes on Books.

The Electric Current. By R. Mullineux Walmsley. London: Cassell and Co., Limited. 1894.

To deal with the whole subject of the electric current in a handbook of some 750 pages so as to include both its theory and its practical applications is no small task. Mr. Walmsley has, however, succeeded in covering the ground with very considerable completeness, and, on the whole, without entering into unnecessary details or unnecessary elaboration.

The book is divided into three parts—production of the current, its laws, and its applications. The first chapter of all is historical, and in it the history of the subject is very briefly summarised. So much concerning the historical method may perhaps be admissible. The history is not taken beyond the time of Faraday. Under the heading of the chemical production of the current, an account is given of a number of typical batteries, including secondary batteries or accumulators. The necessity for dealing with the mechanical or magnetic production of the current gives occasion for a sufficiently full and clearly-given account of the theory of magnetism, leading up from magnetism and magneto-electric induction to a description of the modern dynamo. The second part—laws of the electric current—deals with conduction, chemical action, thermal action, magnetic action, electrical measurements, &c. In the third part—applications of the electric current—the subject is treated in a more condensed way than in the earlier portions of the book. It is arranged under applications of the chemical effect, including electro-plating, electro-typing, electro-metallurgy, and electro-chemistry; applications of the thermal effect, including electric lighting, furnaces, welding, blasting, &c. Under the head of electric lighting are included some practical instructions for the electric lighting of private houses. The applications of the magnetic effect include the electric telegraph and the telephone. The last chapter of the book is devoted to the electric transmission of power and applications of power electrically transmitted, such as for electric locomotion on land and water.

Turning and Mechanical Manipulation. Volume III. By the the late Charles Holtzapffel. Revised by John Jacob Holtzapffel. London: Holtzapffel and Co. 1894.

The great work on "Turning and Mechanical Manipulation," which Charles Holtzapffel left incomplete at the time of his death, has long been, and will certainly long continue to be, the standard book for mechanical amateurs.

As is well known to those interested in the subject, the book outgrew its original scheme. The first two volumes, which dealt respectively with materials and hand tools, were issued during the author's lifetime; the third volume, treating on abrasive and miscellaneous processes which cannot be accomplished with cutting tools, was published in 1850, after his death. For a long time the book remained in this unfinished condition. The author's son, Mr. J. J. Holtzapffel, has, during the past few years, issued the fourth and fifth volumes of the work, in which are treated hand turning and ornamental turning. There yet remains the sixth volume, which is to deal with the principles and practice of amateur mechanical engineering.

The present issue is a revision of volume 3. The book has been very greatly enlarged, having grown from about 400 pages to nearly 800; and if in size it has thus been practically doubled, the illustrations have increased in still greater proportion, for 250 new cuts have been added to the original 180. It will be understood that the 44 years which have elapsed since the first publication of the book have seen considerable advances in the processes with which it deals. The use of emery wheels has practically been introduced since 1850; so has the sand blast, and both of these involved the addition of a large quantity of new matter. In addition to these, there are such important developments as the use of twist drills, while in the many branches of manufacture, such, for instance, as grinding and polishing stone and marble, or grinding and polishing plate-glass, which was formerly effected by hand, is now accomplished by machinery.

In comparing together the old and the new editions, it will be found that the revision has been very complete throughout. The instances occur very rarely in which the information is not brought up to date, and considering the very miscellaneous character of the information provided this must have been an extremely difficult task. An important portion of the volume, a portion to which amateur mechanicians must have made frequent reference, is the description of apparatus, materials, and processes for grinding and polishing. This has been enlarged by half its original length—from 100 pages to 152. There are numerous new entries, such, for instance, as aluminium, a metal which now requires treatment at considerable length, but of which no mention appears in the original list. On such a subject as that of grinding and sharpening cutting tools there would not appear to be very much that is new to be said, but even here we find a whole large section on grinding tools and drills on factitious grindstones and emery wheels; while a whole chapter is added on grinding and sharpening cutting tools to precise forms of angles, or, to speak more accurately, the subject is dealt with in an entire chapter, whereas it formerly only occupied a short section of a chapter. Glass-cutting, glass and gem engraving, lapidary work, the use of diamonds as abrasive and

cutting tools—all are treated at far greater length than in the original work. Full details are given of the use of the sand blast, especially of the process, a process of which probably not much is popularly known, for engraving lithographic stones and plates for printing. In the final chapter—varnishing, lacquering, and bronzing—it might be thought that there was not so much to be said, considering that the standard authority on varnish-making still remains Mr. Neal's paper in the Society of Arts' Transactions for 1833. Even here, however, very much is added, as it may be estimated from the fact that the 30 pages devoted to the subject in the original edition are expanded to 80 in the new.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock :—

January 16.—"Commercial Synthesis of Illuminating Hydrocarbons." By Prof. Vivian B. Lewes. Dr. William Anderson, F.R.S., will preside.

January 23.—"Tea." By A. G. Stanton. Sir Alexander Wilson will preside.

January 30.—"Peking." By Thomas Child.

February 6.—"The Labour Question in the Colonies and Foreign Countries." By Geoffrey Drage.

Papers the dates of which are not fixed :—

"The Separation of Aluminium by the Vautin Process." By Professor William Chandler Roberts-Austen, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. Charleton, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. Crompton, M,I.E.E.

"Electric Lighting of Ecclesiastical Buildings." By Major-General Charles E. Webber, C.B.

"Our Food Supply from Australasia." By E. Montague Nelson.

"Cider." By C. W. Radcliffe Cooke, M.P.

"Light Railways." By W. M. Acworth.

"Improvements in Milling Machinery." By J. Harrison Carter.

Afternoon Lecture.

Thursday, March 14, at Half-past Four.—"Art Tuition." By Prof. Hubert Herkomer, R.A.

Indian Section.

Thursday Afternoons, at Half-past Four o'clock :—

January 17.—"The Lushais, and the Land they Live in." By Captain John Shakespear, D.S.O., Superintendent of the Southern Lushai Hills. Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., will preside.

January 31.—"India and its Women." By S. E. J. Clarke, of Calcutta. (The paper will be read by Sir Alexander Wilson.)

February 14.—"Village Communities in Southern India." By C. Krishna Menon, Lecturer on Agriculture at the Sydapet College, Madras. Sir Charles Arthur Turner, K.C.I.E., will preside.

March 28.—"Chitral and the States of the Hindu Kush." By Captain F. E. Younghusband, C.I.E.

April 25.—"The Coming Railways of India, and their Prospects." By J. W. Parry, A.M.Inst.C.E., late Executive Engineer Indian State Railways.

May 23.—"Punjab Irrigation: Ancient and Modern." By Sir James Broadwood Lyall, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

The meetings of January 17, March 28, April 25, and May 23 will be held at the Society of Arts; those of January 31 and February 14 at the Imperial Institute.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesdays, at Eight o'clock:—

January 22.—"The Resources and Trade of Armenia and the Caucasus." By Dr. A. Markoff.

February 19.—"Paraguay." By A. F. Baillif, Consul in London for Paraguay.

March 5.—"Colonies and Treaties." By Sir Charles M. Kennedy, K.C.M.G., C.B.

April 2.—"Commercial Education in Belgium." By Professor William Layton.

April 30.—"Madagascar." By Captain S. Pasfield Oliver.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

February 5.—"Drawing for Process Reproduction." By Gleeson White. Lewis Foreman Day will preside.

February 26.—"Mediæval Embroidery." By Mrs. May Morris Sparling.

March 19.—"Carpet Designing." By Alexander Millar. J. Hungerford Pollen will preside.

April 23.—"Art of Casting Bronze and Copper in Japan." By William Gowland. Prof. W. C. Roberts-Austen, C.B., F.R.S., will preside.

MAY 7.—"Design, Colouring, and Manufacture of British Silks." By THOMAS WARDLE.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock:—

PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S., "The Arc Light." Three Lectures.

JANUARY 14.—LECTURE I.—Discovery of the electric arc light—Early experiments—The physics of the arc.

JANUARY 21.—LECTURE II.—Optics of the arc—Temperature of crater and of peak—Distribution of light and of invisible radiation.

JANUARY 28.—LECTURE III.—Arc-lamp mechanism—The requirements to be met, and methods of fulfilling them—Alternate current lamps—Special lamps—Qualities of carbons—Accessories.

ALAN S. COLE, "Means for verifying Ancient Embroideries and Laces." Three Lectures.

February 11, 18, 25.

DR. D. MORRIS, C.M.G., "Commercial Fibres." Three Lectures.

March 18, 25, April 1.

JAMES DOUGLAS, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures.

April 22, 29, May 6, 13.

ERNEST HART, D.C.L., "Japanese Art Industries." Two Lectures.

May, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 7...Chemical Industry (London Section), Burlington-house, W., 8 p.m. Dr. Attfield, "An Investigation of the Natural Solidified Sodium Lakes of Wyoming, U.S.A."

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned Discussions on the paper by Mr. William Sturge, "The Burdens on Real Property and Land," and on the paper by Mr. A. Dudley Clarke, "The Incidence of Taxation on Land."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. (Christmas Lectures.) Dr. H. R. Mills, "A Geographical Holiday on the Edge of the Alps."

British Architects, 9, Conduit-street, W., 8 p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Professor Lobley, "Physical Geology of the Globe."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. J. Mackinder, "The Netherlands—a Geographical Study."

TUESDAY, JAN. 8...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Dr. Fleming, "The Work of an Electric Current." (Lecture VI.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Mr. John Sterry, "Standard Plates and some Causes of apparent Alterations in Rapidity."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Arthur Montefiore, "Notes on the Samoyads between the Pechora River and the Kara Sea. Compiled from the Journals of Mr. F. G. Jackson, F.R.G.S." 2. Mr. R. H. Mathews, "The Bora, or Initiation Ceremonies of the Kamilaroi Tribe." 3. Mr. R. Etheridge, jun., "A highly ornate 'Sword' from the Coburg Peninsula, North Australia."

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m. Annual Meeting.

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Sir William H. Flower, "Whales—and British and Colonial Whale Fisheries."

WEDNESDAY, JAN. 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. (Juvenile Lectures.) Prof. C. Vernon Boys, "Waves and Ripples." (Lecture II.)

Geological, Burlington-house, W., 8 p.m. 1. Mr. E. B. Wethered, "The Formation of Oolite." 2. Mr. E. A. Walford, "The Lias Ironstone of the Midlands" (Part I.—Around Banbury). 3. Mr. W. F. Wilkinson, "Notes on the Geology and Mineral Resources of Anatolia (Asia Minor)"

Japan Society, 20, Hanover-square, W., 8½ p.m. Mr. Marcus B. Huish, "The Evolution of the Netsuke."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, JAN. 10...Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. A. P. Laurie, "Waves of Water and Waves of Light."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Inaugural Address by the President, Mr. R. E. Crompton.

Mathematical, 22, Albemarle-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8 p.m. Mr. Arthur Burchett, "The Rendering of Nature into Black and White."

Philological, University College, W.C., 8 p.m.

FRIDAY, JAN. 11...Astronomical, Burlington-house, W., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science, Laboratory, University College, Gower-street, W.C., 4 p.m. 1. Mr. G. U. Yule, "The Passage of an Oscillator Wave-Train through a Plate of Conducting Dielectric." 2. Prof. Ramsay and Miss Dorothy Marshall, "The Heat of Vaporisation of certain Organic Liquids." 3. Mr. N. Eumorfopoulos, "The Thermal Conductivity and Emissivity of Brass in Absolute Measure, and the Influence of Curvature on Emissivity." 4. Mr. A. W. Porter, "Observations on Emissivity and Curvature." 5. Dr. C. V. Porter, "Experiments on the Production of Combination Tones."

SATURDAY, JAN. 12...Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

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No. 2,199. Vol. XLIII.

FRIDAY, JANUARY 11, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

On Wednesday evening, 9th inst., Professor C. V. Boys, F.R.S., delivered the second lecture of his course on "Waves and Ripples." The lecturer measured, by exhibiting the rise between glass plates, the relative surface tensions of clean water, of oily, and of soapy water, showing that soap reduces the surface tension to nearly one-third that of clean water, that is when measured slowly. Lord Rayleigh's method of measuring this within $\frac{1}{100}$th second was next shown, proving that the great reduction is only the work of time. This led, for the first time, to the explanation why a soap bubble is capable of existing.

Going back to the question of waves, the lecturer next exhibited a diagram made on a large Human's logarithmic co-ordinate sheet, from which the wave length, number of waves in a second, and velocity of water waves of all sizes, could be read, and the laws relating thereto exhibited. This at once illustrated the fact that little waves or ripples cannot follow the ordinary law, but that, in consequence of the rumpling and stretching of the surface, which is more efficacious the smaller they are, little waves or ripples must travel faster the smaller they are, and that there must be some intermediate point when they travel most slowly. The diagram also illustrated the same phenomena in the case of mercury and alcohol.

Reference to the diagram showed that ripples $\frac{1}{10}$th inch long, or less, would pass so quickly before the eye as to be quite invisible. This was illustrated by experiment. The surface of water focussed on the screen appeared unaffected by being touched with a point on a feebly-sounding tuning fork. The existence of the ripples was then made brilliantly evident by intercepting the light with a revolving disc rotating in time with the fork. If the disc turned a little too slowly or too quickly, the now apparently almost stationary ripples appeared to slowly creep outwards or inwards. The reduced velocity of ripples on oily water and on soapy water was exhibited by means of a divided dish with clean water on both sides at first. A point from the tuning fork touched the surface in each half, and the ripples were the same size in each. A drop of oil in one half at once reduced the wave-length in that, and a little soap reduced it yet more, the contrast with the still pure water in the other half of the dish making the effect all the more evident. On replacing water by mercury it was seen that the ripples produced by the same tuning fork were smaller.

Two forks, one two octaves above the other, that is, vibrating four times as rapidly, simultaneously produced their own sets of ripples, when it was evident that smaller ones were half, not one quarter, the length. Also, when the rotating disc was made to turn very little more slowly, the smaller waves were seen to travel at twice the speed, thus confirming the truth of the laws expressed on the diagram.

A floating piece of microscope cover glass, straight on one side and concave on the other, reflected the ripples perfectly, giving rise to interference phenomena, or bringing the ripples to a conjugate focus, according to its position.

A diaphragm, carrying a point touching the mercury, responded to the sound of the tuning fork, or of its octave, to an organ pipe, or to the voice, if it were in tune also. The fact that an organ pipe gives a slightly higher note when blown hard, was made clear, for the ripples seemed to travel inwards at first, and outwards when the note was louder. The ripples gave an excellent ocular demonstration of the accuracy of tone of any sounding body. The vowel sounds could not be clearly distinguished, but some small differences were apparent.

During casual disturbance of the mercury surface, ripples could always be singled out of a wave-length and velocity corresponding to the speed of the disc, so that when a point is drawn through still water, if waves of different sizes and velocities travel in all directions, it was shown that a particular ripple pattern should accompany the point. These were exhibited upon the screen, and the similarity

between the ripple pattern and that surrounding a flying rifle bullet was made evident by photographs of the latter.

Finally, in order to examine them more closely, a stream was artificially produced by slowly spinning a large basin of water. Then, as the point was made to travel slowly from the centre to the outside of the parabolic surface, at first where the speed was below the minimum velocity (about 9 inches a second) no pattern was produced; when this point was passed, ripples were seen in front and larger waves behind, each travelling at the same speed. As the point was taken further out in faster moving water, the ripples became smaller, and the angle they made was more acute. Then, in taking the point back to the place where the velocity was just too small to give rise to ripples, they were instantly called into life again by touching the surface of the water with a soapy brush, for the minimum velocity of ripple was now exceeded.

In conclusion, the lecturer expressed his obligation to Lord Rayleigh, whose beautiful researches on surface actions he had attempted to illustrate.

The Chairman (Mr. FRANCIS COBB) proposed a cordial vote of thanks to the lecturer for the interesting lectures he had delivered, which was carried unanimously.

Proceedings of the Society.

CANTOR LECTURES.

EXPLOSIVES AND THEIR MODERN DEVELOPMENT.

By PROFESSOR VIVIAN B. LEWES.

Lecture III.—Delivered December 3, 1894.

Although the idea of smokeless powders for warfare has always been a dream with strategists, it is only within recent years that they have become an absolute necessity, as with the introduction of quick firing and machine guns into the navy, it became necessary to have a powder giving little or no smoke, if the guns are to be of any use for the objects for which they were intended. For instance, in repelling the attack of torpedo-boats, the use of black powder would entirely defeat the purpose of the guns, as after the first few shots the cloud of smoke would entirely obscure the whereabouts of the attacking force, and render for some time, at any rate, the further use of the guns abortive.

The formation of smoke during the combustion of powder is entirely due to the presence amongst the products of combustion of solid compounds, which, although liquid at the time of explosion, rapidly solidify as the temperature falls, and with the black powders, potassium carbonate, potassium sulphate, and potassium disulphide are the products which cause the fouling of the gun and, together with condensing water vapour, form the dense cloud of smoke which follows the firing of a shot. When using brown powder, although the smoke cloud appears at first to be as dense as with the black powder, it is noticed that it clears away far more rapidly. This is due to the fact that whereas the products of combustion of the black powder only contain 12·8 per cent. of water vapour, the products of combustion from the cocoa powders contain 38·5 per cent. of water vapour, which in condensing carries down with it, by absorption and solution, the finely-divided potassium salts.

The fact that the solid residue from powders consists entirely of potassium compounds from the base of the potassium nitrate employed in powder, naturally suggested the idea of using some nitrate which would give up its oxygen for the combustion of the carbon and sulphur in the same way that saltpetre does, but should have as its base some body which would yield volatile or gaseous compounds. The only inorganic nitrate which would in any way answer this requirement is ammonium nitrate, and many attempts have been made to utilise this in forming a smokeless powder.

Unfortunately, however, ammonium nitrate is a highly deliquescent body, which has the property of so readily absorbing moisture from the atmosphere that the powder made with it would rapidly be converted into mud if exposed to atmospheric influences.

In order to obviate, as far as possible, this difficulty, F. Gans conceived the idea of replacing only a certain proportion of the potassium nitrate in the gunpowder by ammonium nitrate, imagining, by so doing, the hygroscopic character of the ammonium salt would be got over, whilst the formation of a volatile compound, called potassium amide, caused by the union of the potassium with the nitrogen and hydrogen of the ammonium, would occur, and, being volatile, would render the products practically smokeless, and in

view of this theoretic action he christened his compound "amide powder." His views, however, were founded upon considerations which have not stood the test of practice, as the powder so produced was hygroscopic, and by no means smokeless.

The most successful attempt to produce a smokeless powder by the use of ammonium nitrate was made by Mr. Heidemann, one of the original patentees of cocoa powder, whose large knowledge of powder-making and the requirements to be observed, enabled him to so modify Gans's idea so as to obtain a powder which not only gave most excellent ballistics, but which was decidedly less hygroscopic than the ordinary ammonium nitrate powder, and gave but little smoke. This powder, like the cocoa powder, contains a certain definite amount of water as one of its constituents, and with a comparatively dry atmosphere, shows no tendency to absorb more, but with a saturated atmosphere it rapidly shares the fate of the ammonium nitrate powders generally, and becomes pasty. In order to overcome this defect, the cartridges were enclosed in hermetically-sealed metal cases, so as to prevent any absorption taking place, but it was found that the storage of these in ships' magazines—which, as I have pointed out before, are liable to become unduly heated—caused the moisture already present in the powder to become unequally distributed in the cartridges, with the result that there was occasionally a want of uniformity in the action of the powder in the firing, and a tendency to the occasional development of high pressure, and it was considered that this was a drawback to its adoption in the naval service.

In 1886, the attention of European powers was attracted to the acquirement of a satisfactory smokeless powder, and it appeared probable at that time that in France such a powder had been obtained for use in the Lebel magazine rifle.

When Schönbein discovered gun-cotton, it seemed at first as if the question of a smokeless powder had been solved, but as soon as experiments came to be made, it was found that on account of its low density it occupied far too large a volume, whilst when it was rammed into cases, the explosion was often of so violent a character as to produce disastrous results. Many attempts were made by Von Lenk to obviate this trouble by converting cotton threads into gun-cotton, and winding these threads with differen degrees of tightness, generally upon a core of wood, but this system of taming the explosive power of the gun-cotton proved unreliable, and although Von Lenk's system was introduced on a somewhat extensive scale, the unsatisfactory results obtained soon led to its abandonment.

Von Lenk's results having been investigated by Sir Frederick Abel, the experiments were repeated in England with wound cartridges of gun-cotton threads, but with no better results than had been obtained in Austria, and Abel having in the meantime completed the improvements in the manufacture of compressed gun-cotton discs, attempts were made to use these built up into cartridges with varied air spaces, with the object of regulating the rapidity of explosion. No certainty in results could, however, be obtained, and the attempts to utilise it were for the time abandoned.

About this period Messrs. Prentice, of Stowmarket, and Colonel Schultze, in Prussia, had succeeded in making practically smokeless powders for sporting purposes. The Stowmarket preparation consisted of felt-like paper made of a mixture of gun-cotton and ordinary cotton containing 30 per cent. of gun-cotton and 10 per cent. of ordinary cellulose, together with oxidising bodies, made in sheets which were afterwards rolled up into the cartridges. This cartridge depended to a great extent on the presence in it of moisture for the ballistics which it gave, the unchanged cellulose being itself hygroscopic, and aiding hygroscopic action in the gun-cotton. It was impossible, however, to regulate the amount of moisture present, aud when the cartridges had been kept in a warm place the moisture would become too low and the danger of detonation of the gun-cotton would increase, whilst if the cartridges had been kept in a damp place they were apt to burn more like squibs than explosives.

When this trouble was realised, the rolled cartridge was replaced by a cylindrical pellet of slightly compressed gun-cotton pulp, attempts being made to tame down the rapidity of the explosion, and also to waterproof it by impregnating it with a certain proportion of indiarubber, but neither of these cartridges gave sufficiently uniform results to fulfil service requirements.

The Schultze powder on the other hand consisted of granulated wood which, after purification by boiling with dilute sodium carbonate, was washed and treated with a solution of bleaching powder; the mass was then washed,

dried, and soaked in the mixture of strong nitric and sulphuric acids for two or three hours, the temperature at the same time being kept as low as possible, and after getting rid of the free acid in a centrifugal machine, the nitrated wood was washed with water until free from acid, boiled with dilute sodium carbonate, and dried, after which it was steeped in a solution of the mixed nitrates of barium and potassium, and again dried at a low temperature. This powder attained a considerable popularity for sporting purposes.*

Another powder which became very popular for sporting purposes was the well-known E.C. powder, which was first made by Mr. Reid in 1882, and consisted of gun-cotton incorporated with 35 to 40 per cent. of the mixed nitrates of barium and potassium, the mass being granulated and gelatinised by means of mixtures of ether, alcohol, and benzoline, which gave a hard coating to the grain. In this powder the presence of gun-cotton constituted a source of trouble, as the action was occasionally unduly violent, and the hard coating resisted ignition by the flash, and necessitated the use of a powerful cap.

In 1888, the E.C. powder No. 2 was introduced by Mr. W. D. Borland, and in this powder the use of true gun-cotton was entirely done away with, the nitrocellulose being completely soluble, and the hardness of the grain was obtained by treatment with a solvent containing camphor, which acted uniformly throughout the mass, whilst it left the surface in a slightly roughened condition, which enabled the flash to rapidly ignite the powder.

These powders gave very satisfactory results for sporting purposes, and also gave good ballistics with smooth-bore guns, but both the E. C. and Schultze powder left an ash which was considerably harder than that afforded by the old black powder, and which instead of forming a partial lubrication for the succeeding shot, tended to choke rifled guns, so interfering with accuracy in shooting. Moreover, these powders could not be made on a large scale with a sufficient degree of uniformity to fulfil the requirements of service powders.

None of these powders were absolutely smokeless, as the inorganic nitrate used to supply the oxygen necessary for making up the deficiency in the nitrocellulose always gave a certain amount of solid residue, but the amount of smoke given varied a great deal with the kind of nitrate used, the presence of potassium nitrate in the original powder undoubtedly making the smoke much denser than when other metallic nitrates were substituted for it, this being one of the reasons why barium nitrate is employed to replace some of the potassium nitrate in these compounds, and also, of course, because the barium nitrate slows down the combustion.

It is not at all clear in the minds of many experts in sporting powders that an absolutely smokeless powder is any very great advantage over a powder which gives a small initial amount of smoke, which will condense or disperse with sufficient rapidity to enable the marksman to see whether his shot has struck the object aimed at, and the different rate of dispersion of various kinds of smoke render smoke photographs, which have been somewhat popular of late, rather misleading, as upon the moment upon which the photograph is taken will very largely depend the intensity shown by the smoke cloud. For instance, when firing two kinds of powder, at the moment of explosion the smoke given by each may appear to be identical in the photograph, whilst a second photograph, taken half a second later, may show one cloud of smoke to be many times denser than the other.

In this way it would be perfectly easy to prepare a photograph of the smoke produced by the firing of a charge of black prism and S.B.C. powder, which would make the latter appear to give but little smoke, simply because of the lasting power of the products of combustion from the black powder, and the rapid condensation and dispersion of the products from the cocoa powder, owing to its high percentage of readily condensible water vapour.

It has been shown that the compression of gun-cotton causes it to burn much more slowly when ignited under ordinary atmospheric conditions, and it was in this direction that all the early experiments tended, but it was soon found that in the chamber of a gun the pressure forced the flame first formed into the interior of the mass and produced detonation, which, giving no time for overcoming the *vis inertiæ* of the projectile, threw an enormous strain on the gun, and gave very unsatisfactory muzzle velocities. Many attempts were then made to so dilute and tame the gun-cotton by admixture with inert or less explosive substances so as to render it sufficiently slow for this purpose, but with little success, as inequality

* Slight modifications have from time to time been introduced into the manufacture, and even within the last year I believe hardening of the surface by treatment with ether and alcohol has been resorted to.

in ballistics and the risk of detonation always remained an insuperable objection.

The first important step towards doing away with these troubles was the realising that the cause of them was in the hollow fibre of the nitrated cotton, and that no matter how thoroughly the gun-cotton was disintegrated in the hollander during manufacture, or how closely the pulp was compressed in pressing the cartridges, discs, or slabs, you had merely shortened the tubes, and had not done away with them, and that it was only by absolute destruction of the structure of the cotton that the too rapid combustion could be checked and the risk of detonation avoided.

Trinitrocellulose is soluble in ethyl acetate and nitrobenzene, whilst some other substances will convert it into a gelatinous mass, and by utilising such bodies to absolutely destroy the structure of the cotton, and by converting it into a solid substance, which can only burn regularly from the surface, the rate of combustion can be controlled, and the risk of detonation overcome. This method of taming the explosive has made the modern smokeless powder a practical possibility.

The fact that with properly made powders of this character, surface combustion only takes place, can be amply proved by the fact that if the powder be in any particular shape, such as strips or cubes, and the combustion is checked before it is completed, even when fired from a gun, the residue will be found to have the same shape as the original, reduction in size only having taken place, whilst if large masses of such powders be ignited, they will burn away fiercely but without the cumulative action which in ordinary gun-cotton would result in explosion.

In May, 1890, a fire took place at the Ballistite factory at Avigliana in Italy, and over 12 tons of this powerful explosive, consisting of nitroglycerine and nitrocellulose, took fire; the whole quantity burnt away in a few moments without explosion, and with only slight damage to the manufacturing plant, whilst had the explosive ignited been unaltered gun-cotton or even gunpowder, a most fearful disaster would have resulted.

The adoption for service purposes of small calibre rifles and long cylindrical projectiles, has given rise to the necessity for smokeless powders for military purposes, of a different class from those which have proved successful for sporting purposes, and the French Government was one of the first to adopt a smokeless powder for use with the Lebel magazine rifle. The composition of this powder, called the "Vielle" powder, or "Poudre B," was shrouded in extreme mystery; but it is now an open secret that it contained, as its chief ingredient, picric acid, which was also the basis of that much talked of explosive "melinite."

Picric acid, which was originally made by the action of nitric acid upon indigo, is now prepared far more cheaply by the action of nitric acid at a low temperature on carbolic acid and some other derivatives of coal tar.

Phenol, or carbolic acid—C_6H_5HO—is one of the compounds obtained from heavy tar oil, and is much used as a constituent of disinfecting powders and liquids. It crystallises in needle-shaped crystals, possessing a strong, tarry smell, and has a fusing point of 42° C., the liquid boiling at 182° C.; and when a small quantity of the fused acid is poured into nitric acid, a violent action takes place, with evolution of red fumes: when this action has moderated, some of the strongest nitric acid is added, and the liquid boiled, until red fumes nearly cease to be evolved, and, on cooling, a yellow substance, called picric acid, crystallises out, and can be purified by re-crystallising from water.

The change which takes place during the action of the nitric acid upon the carbolic acid may be represented as follows:—

$$\underset{\text{Phenol.}}{C_6H_5OH} + \underset{\text{Nitric Acid.}}{3(HNO_3)} = \underset{\text{Picric Acid.}}{C_6H_2(NO_2)_3OH} + \underset{\text{Water.}}{3(H_2O)}$$

Picric acid may be regarded as a nitro-substitution product, in which three atoms of the hydrogen in the original phenol are replaced by the radical NO_2, and by the action of picric acid on metals or metallic bases, is obtained the class of salts known as picrates.

$$\underset{\text{Picric acid.}}{C_6H_2(NO_2)_3OH} + \underset{\text{Potassic Hydrate.}}{KHO} =$$

$$\underset{\text{Potassic Picrate.}}{C_6H_2(NO_2)_3OK} + \underset{\text{Water.}}{(H_2O)},$$

many of which salts have the property of exploding when heated or struck.

Picric acid is a pale yellow crystalline solid, having the form of plates or prisms, and being but little soluble in cold water, although readily soluble in alcohol. It derives its name from its intensely bitter taste, and, for this reason, has been used in some hop substitutes for bitter ales. It is extensively used as a dye for silk and wool, which it colours a fast yellow.

On heating the crystals of picric acid, they

fuse at 122 C., with partial sublimation, and explode at a slightly higher temperature.

When exploded, the decomposition is somewhat complicated. Nitrogen, carbon dioxide, carbon monoxide, nitric acid, water vapour, and hydrocyanic acid are produced, and a residue of unburnt carbon left behind; an inspection of the formula for picric acid makes it at once evident that there is clearly not nearly enough oxygen for the complete combustion of the carbon and hydrogen present, and for this reason nearly all the picric powders and explosives consist of mixtures of picric acid and its salts, with oxidising substances of a character suitable for supplying this deficiency.

It is now more than 20 years ago since Désignolle first introduced potassic picrate and saltpetre for use as bursting charges for torpedoes and shells, and this was improved upon by Sir Frederick Abel, who substituted ammonic picrate for the potassic salt, the same composition also being adopted in Brugè's picric powder. Soon after this Dr. Sprengel showed that picric acid by itself was capable of being detonated by mercuric fulminate, and in 1885 E. Turpin patented the use of picric acid for shells and torpedoes, and proposed to make it less sensitive to percussion by melting it and pouring it whilst hot into the shells, or by making the grains into a solid mass by means of collodion, and in this way a very great weight of the explosive can be got into a small space on account of the high specific gravity of the fused mass.

Melinite contains picric acid as its chief constituent, mixed with some oxidising substance, or as stated by some authorities, merely made into a compact mass with collodion, and the explosive "lenite" is practically the same substance.

The "Poudre B" was in the form of small yellowish brown tablets of the thickness of a sheet of note-paper, and about one-tenth of an inch square, evidently produced by cutting up thin sheets of material, but it was apparently adopted with undue haste, for promising as the first results appeared to be, yet powders of this description are lacking in stability, this fact being clearly shown by experiments which were carried out at Woolwich at the same time that the stir in military circles was being caused by the exaggerated reports of the success of the new French explosive.

Since that time, the smokeless powders which have been introduced for use in the small calibre rifles may be classified under two headings:—

1. Those consisting of nitrocellulose gelatinised, with or without the addition of nitrobenzene.

2. Those consisting of nitrocellulose gelatinised with nitroglycerine, to which have been added aniline, camphor, vaseline, and other substances of the same kind.

To the first class belong the B.N. powder manufactured by the French Government, which consists mainly of gelatinised nitrocellulose, as also does the German Trodisdorf powder, the surface of which however is coated with graphite.

Rifelite made by the Smokeless Powder Company apparently consists of nitrocellulose made from woody fibre, and gelatinised by acetone and nitrobenzene, whilst the sporting powders made by this company are of much the same character.

The Russian smokeless powder is also nitrocellulose, converted into a horn-like mass by a suitable solvent, and the German small arm powder is of much the same character, camphor also being used.

Two powders of this class are made in America, one being "Indurite," in which insoluble nitrocellulose is gelatinised with nitrobenzene, and the second the "Dupont powder," of much the same composition granulated by a special process.

The methods by which the conversion of the powder components into the finished explosive is attained vary considerably, but in most cases the processes are simple, and consist in first kneading together the nitrocellulose with the solvent in a machine of the same character as those used in large bakeries for kneading the dough. These consist of iron cases, in which shafts rotate carrying screw blades revolving in opposite directions, which causes thorough incorporation and kneading of the substance placed in them. This operation might at first sight appear fraught with some danger, but the mixture of the nitrocellulose with the solvent is practically non-explosive, so that there is no risk unless actual flame is brought in contact with the mass.

The length of time taken in the kneading process varies from three to ten hours, according to the mass of solvent which is employed, a larger quantity requiring far less time than when only a small quantity is used. When this kneading and incorporation is completed, the mass has a soft consistency, and is generally semi-translucent, and is then ready

for moulding into the form of the finished powder. In some cases the mass is converted into grains by suspending it in hot water and blowing steam into it, which disintegrates the mass, and causes it to become granular. In other cases it is squeezed into threads or rolled out into sheets.

The largest proportion of the powders are made in this latter form, the kneaded mass being rolled out into sheets by means of rollers heated by steam, so as to drive out from the mass the solvent, at the same time that the thin sheet is produced, the temperature employed of course depending upon the boiling point of the solvent liquid. These sheets are then cut up into small squares or pieces of the required size in a cutting machine, whilst if the powder is required rather in the form of cubes than in flat flakes, several sheets of the explosive are superimposed upon one another and luted together by means of a fitting cement, and the mass is then cut into the required size.

This is necessary, as if the sheet were originally made of the required thickness, it could not be obtained uniform in density, and would always contain a number of air bubbles, whilst at the same time the solvent could not be properly eliminated.

Perhaps the most startling discovery with regard to explosives that has ever been made was when Mr. Alfred Nobel, who has done so much in the history of explosives of all kinds, showed in 1875 that when the two most powerful of the compound explosives were blended together, their properties became beautifully tempered, so that although the power of doing their full mead of work was still retained, the violence of the action was so far reduced that they became applicable for purposes for which neither of them alone could have been employed.

He found that when nitrocotton is thoroughly saturated and digested with nitroglycerine, the cotton loses all trace of its fibrous quality, and absorbing the nitroglycerine, becomes converted into a gelatinous body having almost the character of a compound. The nitrocotton, macerated with 90 per cent. of glycerine, and the mixture being kept warm, causes the formation of a plastic material from which neither of the components can be easily separated, and this substance, which has become of world-wide repute as a mining explosive, under the name of blasting gelatine, will always be regarded with even greater interest as being the parent of the best of the modern smokeless service powders.

In January, 1888, Mr. Nobel took out a patent for using nitrocellulose mixed with nitroglycerine, with or without the addition of a retarding agent, to form a powder which could be relied upon for use in guns.

It had been found by experiments made in Austria for putting blasting gelatine to military purposes, that this substance might be exploded by the penetration of a bullet or fragments of a shell into the transport waggon, and Colonel Hess, whilst endeavouring to make it less susceptible to accidental explosion, found that by incorporating with the components a small proportion of camphor, and also by increasing the proportion of nitrogun - cotton used, the rapidity of the explosion of the material could be reduced, and the product made of a horn-like character, which had remarkable ballistic properties, and which was uniform and practically smokeless.

Some of the camphor, however, used in the substance remains in it, and this being volatile, its evaporation causes modifications in the ballistic properties of the powder, and attempts have been made to improve upon this by replacing the camphor by other substances which would play the same part as the camphor, and which would not have the same drawbacks.

The powder so made by Nobel, and known by the name of ballistite, is extensively used in Italy and Germany. As manufactured in Italy, it contains equal parts of nitrocellulose and nitroglycerine, with the addition of a half per cent. of aniline, and when used in the form of threads or cords is called "Filite." The German ballistite contains a rather larger per-centage of nitrocellulose, and the finished material is coated with graphite.

In making the ballistite, the original method was to absorb the nitroglycerine by the collodion cotton in a vacuum vessel, and having pressed out the excess of nitroglycerine, to warm the remainder in order to dissolve the collodion cotton, but a far simpler device has since been introduced by Messrs. Lundholm and Sayers, by which the solution of the nitrocellulose and the glycerine is rapidly brought about.

If the nitrocellulose be slightly moistened, its solubility in nitroglycerine is very greatly retarded, but if the nitrocellulose be suspended with nitroglycerine in warm water, and the mass then agitated by blowing air through it, the incorporation of the nitroglycerine and the nitrocotton takes place with considerable rapidity at a temperature of about 60°.

When the incorporation is completed, and the mass thoroughly gelatinised, a large proportion of water is removed by pressure, and the mass is then rolled into sheets under heated rollers, and cut to the required size of flake and dried in the usual way.

In these powders the collodion cotton (dinitrocellulose) is employed, as it was well known that nitroglycerine alone does not dissolve the trinitrocellulose; but whilst endeavouring to avoid slight imperfections which had been noticed in the behaviour of the ballistite, Sir Frederick Abel and Professor Dewar found that if trinitrocellulose and nitroglycerine were mutually taken up by a liquid capable of dissolving them both, on evaporating off the solvent, the trinitrocellulose and the nitroglycerine remained behind in the most perfectly incorporated and gelatinised condition, and it is to this principle that we owe our English smokeless service powder, Cordite, which contains 58 per cent. of nitroglycerine, 37 per cent. of trinitrocellulose, and 5 per cent. of vaseline.

Cordite could be perfectly well made by incorporating trinitrocellulose with nitroglycerine by aid of such a solvent as acetone, but the perfect freedom from any solid or liquid products of combustion during the explosion of such a mixture leaves the bore of the gun so clean that great friction is set up between the metal of the bore and the bullet, with the result that metallic fouling of the bore, due to abrasion of the bullet, and wear of the bore due to the same cause takes place, and it is chiefly to overcome this trouble that the vaseline or petroleum jelly is incorporated with the other ingredients, as it gives a thin film of solid matter in the bore and greatly reduces this trouble, besides giving the cordite the power of resisting water, and facilitating the squeezing of the material into threads.

The gun-cotton employed in the manufacture of cordite is made at Waltham Abbey by the same process as described in the last lecture, the only difference being that no lime-water, caustic soda, or whitening is added in the last "poaching," and after moulding the pulp is only subjected to a pressure of about 40 lbs. on the square inch, and, after the process, still contains about 40 per cent. of moisture, which is afterwards "stoved" down to 0·5 per cent. If the gun-cotton had been pressed as in making torpedo slabs, under a pressure of 4,000 lbs. to the square inch, it would have been too dense to have been afterwards properly acted upon by the acetone and nitroglycerine in making the cordite.

After the gun-cotton has been dried in the stoving-house at 100° Fahr., it is taken to the nitroglycerine store in a covered trough, and the right proportion of nitroglycerine is poured upon it, and the two substances lightly mixed by hand so as to ensure complete absorption of the nitroglycerine by the gun-cotton.

The mixture is now taken to another house, where it is put into a kneading machine, in which slowly revolving blades incorporate the solvent acetone with it, and keep it thoroughly mixed and kneaded whilst the solvent action is proceeding. As this action approaches completion, petroleum jelly or vaseline is added, and the whole charge is incorporated in the machine for seven hours, and is then ready for pressing. Strong gun-metal cylinders are charged with the mixture under low hydraulic pressure, and these cylinders are then placed in position in the pressing machine, where a rammer of steel driven by a screw presses upon the mixture and drives it out through a small hole in the bottom of the cylinder as semi-gelatinous cords or threads of the required size. As these leave the machine they are supported on a running web, and cut automatically into required lengths, which are arranged for drying in shallow trays. The smaller sizes are wound on large reels, and when these are filled with the cordite they are, like the larger sizes, taken to the drying-house and exposed to a temperature of 100° Fahr., which drives off the acetone and renders the threads tougher. The finished cordite is now blended by mixing a number of batches together, and the substance is then ready for making into cartridges.

Acetone, which is used in making the cordite and also as a solvent in some other smokeless powders, is a compound having the formula C_3H_6O. It is a colourless fragrant liquid, having a specific gravity of 0·81 and boiling at 56·3° C. or 133·3° Fahr. It is inflammable, and burns with a luminous flame, and will mix with water, alcohol, and ether. It is essential for purposes such as the making of smokeless powders, that it should be as pure as possible, as any traces of impurity would probably be left behind on its evaporation and remain in the powder. That used at Waltham Abbey has a specific gravity of 0·7965, and 98 per cent. of it distills off between 56·2 and 56·4° C. When such acetone is treated with a 0·1 per cent. solution of potassium permanganate, it should retain its rose colour for more than

two minutes, and the Waltham samples will generally do so for nine. In addition to this point, it should not have more than 0·005 per cent. of acidity nor contain more than 0·1 per cent. of aldehyde. Vaseline or mineral jelly used is obtained during the distillation of petroleum, and consists mainly of portions distilling at temperatures above 200° C.; it has a boiling point of about 278° C., and has been given the formula $C_{16}H_{34}$. Cordite burns when ignited in air and leaves no residue, and gives practically no smoke. It is not nearly so sensitive to percussive detonation as gun-cotton, though perhaps a little more so than gunpowder, and is so difficult to ignite in a gun that a primer of R.F.G. black powder has to be employed. When a rifle bullet is fired into cordite, it burns quietly.

It is unaffected by both frost and salt water, but when exposed for any length of time to the latter, it is better that it should be washed with fresh water and carefully dried at a temperature below 100° Fahr. before being stored.

It has undergone several climatic trials which have so far proved satisfactory, the severe cold of a Canadian winter, and the heat of an Indian summer having failed to shake the stability of the composition or to sensibly alter its shooting powers, whilst the cordite returned after these severe trials showed, on analysis, no alteration in composition, and, it has now been passed as a service store with the proviso that the magazines are properly ventilated, and that the temperature does not rise above 100° Fahr., conditions which, as I have already pointed out, should also be observed with black and brown powders, and could be perfectly well complied with on board ship by water-jacketing the magazines, or even by surrounding them with a double bulk head, the spaces between which could be packed with silicate wool or other non-inflammable non-conductor.

The erosion caused by the use of cordite in small calibre guns is not appreciably greater than with powder, but as the size of the gun and the charge increase, the erosion becomes more marked as far as the first few calibres from the powder chamber are concerned.

The erosion caused by cordite is of a totally different character from that due to powder, the surface appearing to be washed away smoothly by the gases and not pitted and eaten into as with powder, so that efficient obturation of the shot can always be obtained by suitably shaped driving bands. The erosion also extends over a much less surface than with powder.

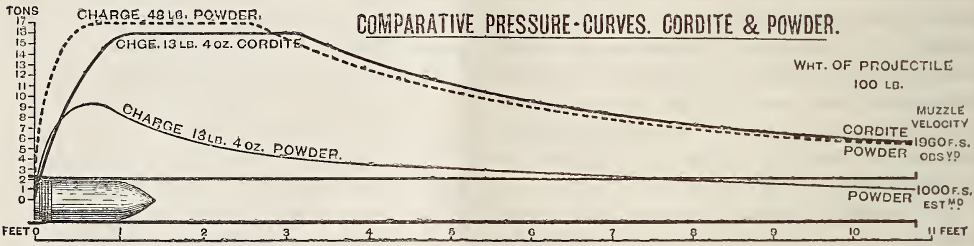
As regards the ballistics obtained by the use of cordite, the results of experiments made up to the present time are most satisfactory, and the following comparative Table, which shows the pressure and muzzle velocities obtained from powder and cordite respectively, speaks for itself, and shows that the use of cordite enables a far smaller charge to be employed, and gives a large increase in muzzle velocity without corresponding increase in the pressure in the gun.

Powder.	Gun.	Charge.	Velocity.	Pressure.
Powder.............	Magazine Rifle.	71·5 grs.	1,830 $\pm$ 50	19
Cordite.............	,,	31 grs.	2,000 $\pm$ 40	15
Powder.............	12-pr. B. L.	4 lbs. S. P.	1,710 $\pm$ 20	15
Cordite.............	,,	1 lb.	1,680 $\pm$ 20	14
Powder.............	4·7-in. Q. F.	12 lbs.	1,786 $\pm$ 20	16 to 17·6
Cordite.............	,,	5 lbs. 7 oz.	2,185 $\pm$ 25	15
Powder.............	6-in. Q. F.	29 lbs. 12 oz.	1,882	15
Cordite.............	,,	13 lbs. 4 oz.	2,200 $\pm$ 25	15

There is a considerable amount of misunderstanding as to the action of cordite in guns. It is observed that certain velocities are obtained with particular guns with less chamber pressure with cordite than with powder, and the erroneous conclusion is come to that the pressures must be higher in the chase, but this is not the case. The reason that the cordite give the higher velocities with lower pressure is that it has less work to do.

It must be clearly borne in mind that not only the projectile but also the products of combustion have to be expelled from the gun, these latter having ultimately even a higher velocity than the shot, and in using black powder the weight of the charge is far greater than with cordite. In black powder also, 57 per cent. of the charge is inert, whereas in the case of cordite the whole is operative, and gives the charge a great gain in efficiency over the black powder.

Through the kindness of the Director-General of Ordnance Factories, Dr. W. Anderson, F.R.S., I am enabled to give a curve, representing the pressures given by the cordite, as compared with gunpowder, in the 6-inch guns.



The smokeless powder, being of comparatively new manufacture, and only dating back a few years, it is unreasonable to suppose that it should be faultless in every respect, and there are still many considerations which will have to be studied by the light of practice before anything approaching finality will have been reached.

The products of combustion given by all such powders are far richer in carbon-monoxide than the products evolved by the old powders, and we have yet to see what the effect of this will be in the turrets and fighting decks of our warships when in action, as it is a perfectly well ascertained fact that a half per cent. of this gas in the atmosphere renders it fatal to those who breathe it, but the probabilities are that it will be no more harmful than the old powder, as with breechloading guns only a small proportion of the products of combustion will find their way inboard. So far, however, no complaints have been received, either from the army or navy, of any inconvenience caused by the products of combustion.

Name of Explosive.	Calories, per gram.	Permanent gases, c c. per gram.	Aqueous vapour, c c. per gram.	Total volume of gas, 0° C. 760 m.	Per cent. composition of permanent gases.					Co-efficient of potential energy.
					CO_2.	CO.	CH_4.	H.	N.	
E C powder, English..	800	420	154	574	22·9	40·6	0·5	15·5	20·5	459
S S, Sporting	799	584	150	734	18·2	45·4	0·7	20·0	15·7	586
Troisdorf, German ..	943	700	195	895	18·7	47·9	0·8	17·4	15·2	844
Rifleite, English	864	766	159	925	14·2	50·1	0·3	20·5	14·9	799
B N, French	833	738	168	906	13·2	53·1	0·7	19·4	13·6	755
Cordite, English	1,253	647	235	882	24·9	40·3	0·7	14·8	19·3	1,105
Ballistite, German ..	1,291	591	231	822	33·1	35·4	0·5	10·1	20·9	1,061
Ballistite, Italian and Spanish	1,317	581	245	826	35·9	32·6	0·3	9·0	22·2	1,088
Nitrocglycerine	1,652	464	257	741	63·0	—	—	—	*33·0	1,224
Nitrocellulose, N 13·30 per cent. ..	1,061	637	203	876	22·3	45·4	0·5	14·9	16·9	929

* Also contains 4 per cent. oxygen.

The most that we can do at present is to strive for the attainment of the best results, and by carefully comparing the effects obtainable with various forms of smokeless powders, to see which of them attains most nearly to success, and to consider thoughtfully the indications given by such comparative tests in indicating the lines of research most likely to lead to ultimate perfection in our service explosive. It must be borne in mind that with our wide possessions, stretching into every variety of climate, where explosives have to be stored for many years, stability of composition is of the utmost importance, and has been the rock on which so many powders offered to the Government, and apparently excellent as propellants, have made shipwreck.

The researches of Messrs. W. McNab and E. Ristori, brought before the Royal Society this year, are a most important addition to our explosives literature in this direction, and with their permission I am enabled to give a Table (p. 144) showing the results which have been obtained, not only as to the relative value, but as to the products of combustion evolved in the explosion of the various smokeless powders now most largely used, and I think the lesson to be drawn from these results is that we may be justly proud of our service explosive, which was founded on the principles first practised by Mr. Alfred Nobel, and perfected by the labours of Sir Frederick Abel and Professor Dewar.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock :—

January 16.—"Commercial Synthesis of Illuminating Hydrocarbons." By Prof. Vivian B. Lewes. Dr. Wm. Anderson, F.R.S., will preside.

January 23.—"Tea." By A. G. Stanton. Sir Alexander Wilson will preside.

January 30.—"Peking." By Thomas Child. Professor Robert K. Douglas will preside.

February 6.—"The Labour Question in the Colonies and Foreign Countries." By Geoffrey Drage. The Duke of Devonshire, K.G., will preside.

February 13.—"Light Railways." By W. M. Acworth.

February 20.—"Rule of the Road at Sea." By Admiral P. H. Colomb.

Papers the dates of which are not fixed :—

"The Separation of Aluminium by the Vautin Process." By Professor William Chandler Roberts-Austen, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. Charleton, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. Crompton, M.I.E.E.

"Electric Lighting of Ecclesiastical Buildings." By Major-General Charles E. Webber, C.B.

"Our Food Supply from Australasia." By E. Montague Nelson.

"Cider." By C. W. Radcliffe Cooke, M.P.

"Improvements in Milling Machinery." By J. Harrison Carter.

"Sand Blast Processes." By John J. Holtzapffel.

"Modern Photogravure Methods." By Horace Wilmer.

Afternoon Lecture.

Thursday, March 14, at Half-past Four.—"Art Tuition." By Prof. Hubert Herkomer, R.A.

Indian Section.

Thursday Afternoons, at Half-past Four o'clock :—

January 17.—"The Lushais, and the Land they Live in." By Captain John Shakespear, D.S.O., Superintendent of the Southern Lushai Hills. Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., will preside.

January 31.—"India and its Women." By S. E. J. Clarke, of Calcutta. (The paper will be read by Sir Alexander Wilson.)

February 14.—"Village Communities in Southern India." By C. Krishna Menon, Lecturer on Agriculture at the Sydapet College, Madras. Sir Charles Arthur Turner, K.C.I.E., will preside.

March 28.—"Chitral and the States of the Hindu Kush." By Capt. F. E. Younghusband, C.I.E.

April 25.—"The Coming Railways of India, and their Prospects." By J. W. Parry, A.M.Inst.C.E., late Executive Engineer Indian State Railways.

May 23.—"Punjab Irrigation: Ancient and Modern." By Sir James Broadwood Lyall, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

The meetings of January 17, March 28, April 25, and May 23 will be held at the Society of Arts; those of January 31 and February 14 at the Imperial Institute.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday evenings at Eight o'clock :—

January 22.—"The Resources and Trade of Armenia and the Caucasus." By Dr. A. Markoff.

February 19.—"Paraguay." By A. F. Baillif, Consul in London for Paraguay.

March 5.—"Colonies and Treaties." By Sir Charles M. Kennedy, K.C.M.G., C.B.

April 2.—"Commercial Education in Belgium." By Professor William Layton.

April 30.—"Madagascar." By Captain S. Pasfield Oliver.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

FEBRUARY 5.—"Drawing for Process Reproduction." By GLEESON WHITE. LEWIS FOREMAN DAY will preside.

FEBRUARY 26.—"Mediæval Embroidery." By MRS. MAY MORRIS SPARLING.

MARCH 19.—"Carpet Designing." By ALEXANDER MILLAR. J. HUNGERFORD POLLEN will preside.

APRIL 23.—"Art of Casting Bronze and Copper in Japan." By WILLIAM GOWLAND. PROF. W. C. ROBERTS-AUSTEN, C.B., F.R.S., will preside.

MAY 7.—"Design, Colouring, and Manufacture of British Silks." By THOMAS WARDLE.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S., "The Arc Light." Three Lectures.

JANUARY 14.—LECTURE I.—Discovery of the electric arc light—Early experiments—The physics of the arc.

JANUARY 21.—LECTURE II.—Optics of the arc —Temperature of crater and of peak—Distribution of light and of invisible radiation.

JANUARY 28.—LECTURE III.—Arc-lamp mechanism—The requirements to be met, and methods of fulfilling them—Alternate current lamps—Special lamps—Qualities of carbons—Accessories.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Silvanus P. Thompson, "The Arc Light." (Lecture I.)

Scottish Society of Arts, 117, George street, Edinburgh, 8 p.m. 1. Report on Mr. George Thomson's Paper, "A New Pneumatic Valve Closet." 2. Mr. S. Z. de Ferranti, "The Ferranti Electricity Meter and its Evolution (illustrated by limelight views), and a Collection of Meters dating from 1883." 3. Mr. George Vair Turnbull, "A Short Exposition on the Taxameter, or Cab Fare Indicator."

Imperial Institute, South Kensington, S.W., 8 p.m. Mr. F. C. Selous, "Adventures and Incidents in Africa."

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Wyke Bayliss, "The Use of the Supernatural in Art."

TUESDAY, JAN. 15...North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m. 1. Mr. A. Young's reply to Discussion of his paper, "Rolling of Ships." 2. Discussion on Mr. F. Caws's paper, "Ship Acceleration and Fluid Resistance." 3. Mr. W. C. Mountain, "The Design and Efficiency of Plant for the Transmission of Power by Electricity."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The Internal Framework of Plants and Animals." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Statistical, Geological Museum, Jermyn-street, S.W., 4¾ p.m. Mr. L. L. Price, "The Colleges of Oxford and Agricultural Depression."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, JAN. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Vivian B. Lewes, "Commercial Synthesis of Illuminating Hydrocarbons."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Charles Harding, "The Gale of December 21st-22nd, 1894, over the British Isles." 2. Annual General Meeting, 8¼ p.m. Address by the President (Mr. R. Inwards).

Microscopical, 20, Hanover-square, W., 8 p.m. Address by the President (Mr. A. D. Michael).

Entomological, 11, Chandos-street, W., 7 p.m. Annual Meeting. Address by the President, "Recent Contributions to our Knowledge of the Geographical Distribution of *Lepidoptera*."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, JAN. 17 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section). Captain John Shakespear, "The Lushais, and the Land They Live in."

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. A. G. Tansley, "Variation in the Floral Symmetry of *Potentilla* and *Tormentilla*, Necker. Part I. "The Modes of Variations." 2. Mr. J. H. Burkill, "Some Variations in the Number of Stamens and Carpels."

Chemical, Burlington-house, W., 8 p.m. 1. Dr. Divers, "Acid Sulphide of Hydroxylamine." 2. Mr. S. Hada, "Mercury and Bismuth Hypophosphites." 3. Mr. A. G. Perkin, "Kamala" (Part III).

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Henry Power, "Nerves and Nerve Centres in Action."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. S. Lilly, "Four English Humorists of the Nineteenth Century." (Lecture I.)

Historical, 20, Hanover-square, W., 8½ p.m.

Civil and Mechanical Engineers, 12, Delahay-street, S.W., 7 p.m. Mr. A. Hanssen, "Checking Engineering Calculations."

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8 p.m. Captain Abney, "A Photograph considered Evolutionarily."

Imperial Institute, South Kensington, S.W., 4½ p.m. Mr. F. W. Rudler, "Decorative Building Stones."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m. (Graduate Section.) Mr. J. Bowden, "Railway Brakes."

FRIDAY, JAN. 18...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Dewar, "Phosphorescences and Photographic Action at the Temperature of Boiling Liquid Air."

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

FRIDAY, JAN. 19...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Lewis F. Day, "Stained Glas Windows and Painted Glass." (Lecture I.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES ON EMBROIDERIES AND LACE.

It has been arranged that the course of Cantor Lectures on "Means for Verifying Ancient Embroideries and Laces" will be delivered by Mr. ALAN S. COLE, in the afternoons of February 11, 18, 25, at 4 p.m., instead of eight o'clock in the evening, as previously announced.

CANTOR LECTURES.

Professor SILVANUS P. THOMPSON, D.Sc., F.R.S., delivered the first lecture of his course on "The Arc Light," on Monday evening, 14th inst., in which he dealt specially with the physics of the arc.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

CANTOR LECTURES.

EXPLOSIVES AND THEIR MODERN DEVELOPMENT.

By Professor Vivian B. Lewes.

Lecture IV.—Delivered December 17, 1894.

The various modifications in gunpowder have been the outcome of the scientific work done upon the subject during the past five and twenty years, and have resulted in converting violent and unreliable explosive effects into beautifully modified actions which are entirely under control, and which enable the artillery officer to predict the strains which will be thrown upon the various parts of his gun, and the muzzle velocity which will be imparted to the projectile.

Smokeless powders also, having their inception at a time when the objects to be striven for were clearly in the minds of those devising them, have been brought to a point not far removed from perfection in a marvellously short period of time.

There is, however, another class of explosives which, although not attracting so much popular attention, is, from a commercial point of view, nearly as valuable and as important as the service explosives themselves, and this class constitutes the so-called "blasting explosives" used by the engineer and the miner for the removal of obstacles placed in his path by nature, and for the winning of ores and coal from their natural resting-places.

In explosives for blasting purposes, the study of ballistic effects has to be abandoned for considerations of a totally different character. When the explosive is required by the engineer for such mechanical work as tunnelling and the removal of rocks and other obstacles in a water-way, or when such bodies are required for the purpose of bringing down masses of slate and stone in quarries, the primary points which claim attention are, first, safety in handling; secondly, the fitness of the explosive to do the work required of it, *i.e.*, shall it have a shattering and disintegrating effect which shall allow of the ready removal of the *débris*, or shall its action partake more of an upheaval and steady push, which will separate the mass in blocks fitted for cutting into slabs or other forms? thirdly, during its combustion such an explosive must not give off gases which, in the confined and ill-ventilated spaces in which they have often to be used, are likely to be actively dangerous to the life and health of those exposed to the air contaminated by such fumes. For use in coal-mines, however, these points, although of great importance, are overshadowed by the question of safety, and the ideal in explosives for such work must also be free from the risk of giving rise to the ignition of explosive mixtures existing in the mine, whether the mixture be firedamp, traces of firedamp and dust, or mixtures of dust and air alone; but inasmuch as all explosives of this class claim perfection in both directions, it will be best to consider the composition and effect of those mining explosives most largely used in this country, and afterwards to discuss how nearly they approach to these requirements.

In the earlier days of mining, gunpowder was the only blasting agent employed, but the discovery by Alfred Nobel, in 1864, that nitroglycerine could be used with tremendous effect for blasting purposes, and his patenting it under the name of "Nobel's blasting oil," gave rise to an entirely new era, and when, in 1866, the dangerous character of this substance led to legislative restrictions, it was Nobel who complied with the requirements of the time by converting his blasting oil into the powerful and effective explosive, which we have already discussed under the name of dynamite.

During the succeeding years many attempts were made to modify and improve upon this idea, but the next great era in blasting explosives may be taken as being made in 1873, when Dr. Sprengel read a paper before the Chemical Society on a new class of explosives. In this paper he pointed out that in the then existing explosives there were considerable variations between the amount of available oxygen present and the amount of combustible matter to be burnt by it, and that the proportions, as a rule, were not such as to give the highest explosive value, some of these bodies, as in the case of gun-cotton, containing too small an amount of oxygen for complete combustion, whilst nitroglycerine contains more than sufficient, and he suggested that higher explosive values could be obtained by employing mixtures which might either be solid, liquid, or the two combined, and one of which should be a hydrocarbon, containing the elements carbon and hydrogen in a condition favourable to their rapid combination with oxygen, whilst the second should be an easily decomposable compound, which could be made available for supplying the necessary oxygen for the combustion of the hydrocarbon, and which could be mixed with it in the proportions necessary to give the highest explosive value.

Amongst the advantages claimed for such explosives is the important one of safety in transit, as the mixing of the ingredients need only take place when the body is required for use, and the two constituents when separated being non-explosive, there would be no danger until such admixture was made. Dr. Sprengel showed also that mixtures of potassium chlorate and such bodies as benzine, petroleum, and phenol could be detonated and exploded with great violence. This class of explosives, named after the inventor, "Sprengel explosives," has been largely adopted for blasting purposes. The principal are—

Rack-a-rock, a mixture of potassium chlorate and petroleum, or, in some cases, nitrobenzol, which obtained notoriety from being the material used in the Hell-gate explosions, when the rocks at the mouth of New York Harbour were destroyed.

Hellhoffite, a mixture of nitrated tar oils with the strongest nitric acid.

Oxonite, containing picric acid and nitric acid, which are mixed just before use.

The foregoing explosives are all prohibited for use in England, on account of their sensitiveness to friction, and their general instability. On this account, in 1886, a group of safety explosives was introduced, consisting of dinitrobenzol or nitronaphthaline, mixed with either nitrate of ammonium or nitrate of potassium. The principal of these are known as ammonite, bellite, roburite, and securite, and have been specially introduced as safety explosives for mining work.

The next era in blasting explosives may be taken as dating from 1875, when Nobel, in the December of that year, took out his first patent for blasting gelatine, a substance which figured so prominently in our last lecture as the parent of our successful service explosives.

In discussing the composition and properties of these mining explosives, it will be convenient to divide them into three classes:—

(1) Blasting powders of the same character as gunpowder; (2) Sprengel explosives; (3) nitroglycerine explosives; which will cover all the explosives most used for blasting purposes, with the exception of tonite, which is a mixture of nitro-cotton with mineral nitrates.

Under the first heading we find ordinary gunpowder, and also the commoner forms of blasting powder in which the sulphur is considerably increased at the expense of the potassium nitrate.

The following Table gives an idea of the composition of such powders.

	England.	France.	Italy.
Potassic nitrate	65	62	70
Sulphur	20	20	18
Charcoal	15	18	12

The result of this alteration of composition is to increase the volume of permanent gases given off by the powder, and at the same time to reduce the heat energy of the explosion, but in obtaining a slight lowering of temperature, the poisonous constituent of the products of combustion, carbon monoxide, is increased to

a very serious extent, and this alone should render the use of such powder inadmissible, whilst it has several other very serious disadvantages, which will be discussed later on.

The following Table gives a clear idea of the alteration brought about in the composition of the products of combustion by the increase in the amount of sulphur present, and reduction in the potassic nitrate :—

	Gunpowder, fine grain.	Mining powder.
Carbon dioxide	50·62	32·15
Carbon monoxide	10·47	33·75
Nitrogen	33·20	19·03
Sulphuretted hydrogen	2·48	7·10
Marsh gas	0·19	2·73
Hydrogen	2·96	5·24
Oxygen	0·08	0·00
	100·00	100·00

The Sprengel explosives have been largely used for blasting purposes, both abroad and in this country; those used here consist of mixtures of nitrated hydrocarbons and ammonium or potassium nitrate. Roburite, introduced by Dr. Carl Roth, is a simple mixture of nitrate of ammonium with chlorinated meta-di-nitro-benzol. The nitrate of ammonium is first dried and ground, then heated in a closed steam-jacketted vessel to a temperature of 80° C., and the melted organic compound is added, and the whole stirred until an intimate mixture is obtained. On cooling, the yellow powder is ready for use, and is stored in airtight canisters, or is made up into cartridges. Owing to the deliquescent nature of the nitrate of ammonium, the finished explosive must be kept out of contact with the atmosphere, and for this reason the cartridges are waterproofed by dipping them in melted wax.

This mixture is not exploded by ordinary percussion, firing, or electric sparks. If a layer of the explosive is struck a heavy blow with a hammer, the portion directly receiving the blow is decomposed, owing to the heat developed, but no detonation whatever takes place, nor are these portions of the substance around the spot struck in any way affected, whilst, if roburite be mixed with gunpowder and the gunpowder be then ignited, the latter explodes and scatters the roburite without firing it.

The roburite can only be exploded by a specially powerful detonator, and on decomposition the gases evolved contain no combustible constituents, but consist only of carbon dioxide, water, and nitrogen, with a small trace of hydrochloric acid gas, which is at once condensed by the large volume of water vapour evolved, and gives rise to no inconvenience.

Ammonite is another explosive of this class, which is manufactured from ammonium nitrate and dinitronaphthalene, these substances being blended in the proportions to give, as the products of combustion, carbon dioxide, water vapour, and nitrogen, but during the decomposition taking place, probably some more complex action occurs, as small traces of ammonia can generally be detected.

Naphthalene, $C_{10}H_8$, which is obtained from coal-tar, and which is, perhaps, better known as the "albo-carbon," employed in certain forms of gas-lamps, is acted upon with strong nitric acid, with the replacement of two equivalents of the hydrogen by the NO_2 radical. The resulting compound is then carefully freed from acid, and is ready for use. Ammonium nitrate, carefully dried, is then incorporated with it by heavy edge-runners in mills, which are heated by steam, and which are also fitted with arrangements by which the temperature of the charge can be controlled. One hundred and fifty pounds of this mixture are ground in this way until the required degree of fineness and incorporation is arrived at, and the mixture, whilst warm, is passed through a sifting-machine, which separates any particles not sufficiently ground, which are returned to the mill. The finished explosive is then ready for making up into cartridges, and the temperature is kept constant until the whole of the operations are finished.

The cartridge-cases consist of solid-drawn tubes of a lead and tin alloy, in which the compound can be kept from the action of the atmosphere upon the deliquescent ammonium nitrate, and when the cartridge is required to be prepared for firing, a part of the metal tube at the end of the cartridge is cut off by a special tool, and the detonator with fuse attached inserted, the soft metal of the tube being pressed tight round the fuse. This substance, like roburite, only explodes when detonated by a strong charge of fulminate of mercury.

Bellite, which was patented in 1885, consists of a mixture of dinitrobenzene with ammonium nitrate, the latter being kept rather in excess.

Securite consists of ammonium nitrate and dinitrobenzene, but from the proportion of nitrate used it is probable that carbon monoxide is produced. These cartridges are coated with nitrated resin, in order to protect them from the action of the atmosphere.

The third class of mining explosives consists of nitroglycerine absorbed by various substances, which will render it less liable to accidental detonation.

Dynamite No. 1 consists of nitroglycerine absorbed by Keiselguhr, and this was discussed in a former lecture.

Dynamite No. 2 consists of nitroglycerine absorbed by a mixture of potassium nitrate and charcoal, the whole being kept homogeneous by the addition of 1 per cent. of solid paraffin or ozokerit.

Lithofracteur is composed of nitroglycerine mixed with an equal weight of a mixture of sawdust, keiselguhr, and baric nitrate, and generally also contains a small trace of sulphur.

Carbonite consists of 25 parts of nitroglycerine mixed with no less than 40 parts of wood meal, and about 34 parts of sodic or potassic nitrate, and 1 per cent. of sulphur.

All these mixtures, unless properly protected, are liable to the great drawback of occasionally exuding nitroglycerine, especially if water be present, and then they become highly dangerous to use, whilst another serious drawback is their liability to freeze, which will take place by continued exposure to a temperature of 4° C., or even slightly higher.

Carbodynamite, introduced by Mr. Walter Reid, consists of nitroglycerine absorbed by very lightly burnt cork charcoal, the absorbent power of which is so great that not only can it be made stronger than in the other cases, but liability to exudation under water seems to be got rid of.

The other class of dynamite explosives, namely, nitroglycerine absorbed by an explosive agent, was invented by Mr. A. Nobel, who discovered that nitrated cotton would dissolve in nitroglycerine with the formation of a solid product. In practice, 93 parts of nitroglycerine are heated in a copper water bath to about 35° C., and 7 parts of nitrated cotton—a mixture of mono- and dinitrocellulose—stirred in gradually. As the cotton dissolves the mixture gelatinises, and on cooling solidifies. This substance, called "blasting gelatine," is semi-transparent, of specific gravity 1·5 to 1·6, and is not altered by submergence in water. It freezes at 40° C., but, unlike keiselguhr dynamite, it is very easily exploded in this state by shock. A bullet may be fired through a heap of unfrozen cartridges of blasting gelatine without any explosion, whilst similarly fired through frozen cartridges never fails in exploding them.

Gelatine dynamite and gelignite are prepared by adding potassic nitrate and wood meal to the blasting gelatine in varying proportions.

The addition of 4 per cent. of camphor to the blasting gelatine increases the solidity, and at the same time makes the mixture less sensitive to shock. A preparation is made and sold under the name of camphorated gelatine. Nitromagnite, dynamagnite, forcite, Giant powder, Vulcan powder, Atlas powder, Judson powder, Hercules powder, and Lignin dynamite, are all modifications of the above forms of dynamite and blasting gelatine that have been used here or abroad.

We are now in a position to examine into the requirements which shall be fulfilled by a really good blasting explosive for mining work, which may be tabulated as follows :—

1. Safety in handling.
2. Safety in explosion.
3. Safety after explosion—*i.e.*, that the products of combustion shall be as little deleterious as possible.

The factors which tend to safety in the handling of blasting explosives are that the substances shall not be liable to explosion except by means of a detonator, and must not be liable to ignition by ordinary knocking about or even by a chance spark, and also must not be liable to freeze.

When we come to examine the explosives in use for blasting purposes we find that the mining powders are fairly safe from these points of view as, although many authorities state that gunpowder can be exploded by a blow, the statement is somewhat misleading. It is perfectly true that if the powder be placed upon an iron anvil and then be struck so violent a blow with an iron hammer that the force of impact raises the temperature to the igniting point of the powder, you then have the portion so heated decomposing, but any one who has tried the experiment will realise that an accident from such a cause is practically impossible.

Experiments have been made which show that the power of bringing about such results depends a good deal upon the materials upon which the blow is struck, and the following list shows this, a blow from iron upon iron

being most liable to give rise to ignition, whilst a blow from copper upon bronze is least likely, the intermediate metals show the tendency in decreasing order:—Iron upon iron, iron and brass, brass and brass, lead and lead, lead and wood, copper and copper, copper and bronze.

Such ignition cannot however, in most cases, be in any way confounded with detonation. If a thin sheet of gun-cotton be placed upon an iron anvil and be then struck a heavy blow with an iron hammer, the portion of gun-cotton struck is ignited, but does not communicate its combustion to the surrounding mass, whereas I think it would be found that it would be impossible to detonate any portion of the sheet of gun-cotton without instantaneous decomposition of the whole of the mass, but we also know perfectly well that there are many substances, such as nitroglycerine and its derivatives, which would be detonated by a simple blow in this way, and it cannot be too strongly insisted upon that there is a very marked difference between the two phenomena.

If a 60 lb. weight, pointed at one end, be so arranged as to slide freely in a frame in such a way that its point will impinge on a rigid steel disc, it will be found that, when falling from a height of from 6 to 12 inches, it will invariably detonate such substances as dynamite, gelignite, blasting gelatine, and carbonite. With gun-cotton or gun-cotton powders, the weight dropped from a height of 2 or 3 feet, will give a sharp explosion of the portion immediately struck, and occasionally portions of the surrounding material may be ignited, but not exploded.

If the same experiment be tried with such Sprengel explosives as roburite, it will be found that a drop varying from 1 foot to 40 feet fails to detonate it, the only effect being that the small portion receiving the impact of the blow is decomposed, but no flame is seen, and there is no communication of the decomposition to the surrounding materials.

If a small quantity of dynamite be placed in such a position as to receive the impact of the blow, and be then surrounded with roburite, the whole of the mass is detonated, showing that true detonation, capable of being communicated to the surrounding material, has been set up; but when the roburite is so placed as to receive the full force of the blow, no explosion of the dynamite takes place, showing clearly that there has been no detonation.

The fact that such compounds as roburite or ammonite, containing ammonium nitrate as the oxidising material, can be so decomposed, is at once explained by the fact that decomposition of ammonium nitrate alone can be brought about when the heat developed by the blow reaches the same temperature at which dry powdered ammonium nitrate is broken up.

Further experiments in this direction have shown that it is perfectly impossible to detonate, or completely explode, cartridges of the ammonium nitrate explosives except by a charge of nitroglycerine or its derivatives, or by mercuric fulminate. We may, therefore, take it that such explosives as ordinary blasting powder and the so-called Sprengel explosives, of which roburite may be taken as the type, are free from any chances of explosion by percussion, whilst nitroglycerine and the blasting explosives obtained from its admixture with other substances are liable to this, and are rendered still more unsafe by the tendency of the nitroglycerine to freeze at an easily-reached temperature, the necessity of thawing them before detonation being a grave source of danger.

As regards ease of inflaming by increase of temperature or by accidental spark, it is found that the nitro compounds all have low points of ignition ranging from a few degrees below 200° C., whilst gunpowder ignites at a temperature which is generally given as from 295° to 316° C., and certainly could not inflame below 250° C., which is the ignition point of sulphur. I do not know that the temperature of ignition of such safety explosives as roburite has ever been ascertained, but the fact that when a mixture of gunpowder and roburite is ignited, the roburite is scattered without ignition, certainly points to its being high.

In coming to the question of safety during explosion, we have to consider a subject of far wider and graver import, as it is upon this that the safety of the lives of thousands of miners employed in the country in winning coal from the seams largely depends.

From the time of Sir Humphry Davy's classical researches in the early part of this century on colliery explosions, the subject has always occupied an enormous amount of attention, and has enlisted a large amount of public sympathy, and yet even at the present time there are many factors which are not fully provided against.

Until quite recently explosions in mines were always attributed to the accidental ignition of mixtures of air and methane, to which the name of "firedamp" is given, and un-

doubtedly this cause is the prime factor in this class of disaster, and the introduction of such precautions as safety lamps at once brought about a considerable reduction in the number of explosions taking place. Many disasters, however, still continued to occur under apparently mysterious circumstances, the conditions being such that any large proportion of methane in the air of the mine appeared practically impossible, but investigations of such explosions showed that coal dust, in a dry and finely powdered condition, had generally been present in the mine at the time of the explosion, and the coked residue of this dust was found afterwards on the surfaces exposed to the explosive wave, and years of experimental investigation by scientific men of the greatest ability proved the fact that air containing so small a proportion of methane as to be itself perfectly non-explosive becomes a good explosive again when holding dry and finely divided coal dust in suspension; and within the last few years explosions have taken place in mines, which have always been celebrated for their freedom from any trace of methane. Further experiments have been made by Mr. H. Hall and Mr. W. Galloway, who have shown that the violent ignition of dust-laden air is possible by a blown-out shot, even if the air in the mine be free from any trace of marsh gas, and there is evidence to show that the explosion is developed in throbs or waves.

It is, therefore, found that the explosions in mines may be brought about, first by the ignition of a mixture of methane and air, in which the former rises above 1 volume to 16 of air, these mixtures being explosive until a proportion of 1 volume of marsh gas to 5 of air is reached; secondly, by mixtures of air, coal dust, and methane, in which the amount of the latter may be excessively small; lastly, by mixtures of coal dust and air. With regard to those explosions caused by coal dust and air alone, the Royal Commission on explosions from coal dust in mines, in their second report, published this year, say—

"On a general review of the evidence on this point, we have no hesitation in expressing our opinion that a blown-out shot may, under certain conditions, set up a most dangerous explosion in a mine, even where firedamp is not present at all, or only in infinitesimal quantities; and while we are prepared to admit that the danger of a coal dust explosion varies greatly according to the composition of the dust, we are unable to say that any mine is absolutely safe in this respect, or that its owners can properly be absolved from taking reasonable precautions against a possible explosion from this cause. But even if we had been able to come to a different conclusion, and to agree with the minority of the witnesses examined, who think that coal dust alone cannot originate an expiosion, we should still have to call attention to the serious danger which results from the action of coal dust in carrying on and etxending an explosion which may have originally been set up by the ignition of firedamp."

One of the most interesting and instructive explosions which have taken place recently was that which occurred a little more than a year ago at the Camerton Collieries, Somersetshire, in which, so far as investigation could go, no trace of combustible gas could be found in the mine at any period prior to the explosion or subsequent to it, and in which everything pointed to the explosion being entirely due to the presence of dry coal dust in the air.

Of interest, also, are the experiments made by Mr. H. Hall, at the latter end of 1892, and the early part of 1893, and reported upon by him to the Secretary of State on January 23, 1893, in which he shows by conclusive experiments that dry coal dust, under conditions frequently present in coal mines, and in the entire absence of firedamp, may be inflamed by a blow-out gunpowder shot, and cause a disastrous colliery explosion.

The evidence which can be collected from the investigation in the Camerton disaster, and from Mr. Hall's experiments, point, I think, to a cause for such explosions, which, as far as I know, has been overlooked, and which is, I think, worthy of the gravest attention. Both at the Camerton Colliery and in Mr. Hall's experiments, powder was the blasting agent used, and such powder as is employed for this purpose gives, amongst the products of its combustion, nearly half the volume of permanent gases in the condition of carbon monoxide, methane, and hydrogen, as was shown when we were discussing mining powders.

In the Camerton explosion, it seems probable that about $1\frac{1}{4}$ lbs. of such powder was used in the shot which caused the disaster, and this quantity of powder would give roughly a little over three feet of inflammable gas, which when mixed with pure air would give over ten cubic feet of an explosive or at any rate a rapidly burning mixture, and experiments which have been made upon the effects of firedamp and dust combined in causing colliery explosions show conclusively that even

when the firedamp is present in such minute quantities as to form a mixture very far removed from the point of explosion, it still makes the mixture of coal dust and air highly explosive; and from experiments which I have made, it is perfectly clear that traces of carbon monoxide will do exactly the same thing when the air is laden with coal dust, whilst the temperature of ignition is slightly lower than with methane, so that in the case of the Camerton Colliery, it being perfectly well ascertained that the air was charged with coal dust, the probabilities are that not ten feet but a far larger volume of explosive mixture was formed by the rapid escape of the products of combustion into the coal-laden air, and this being ignited either by the flame or redhot solid products driven out into it by the blown-out shot, would initiate a considerable area of explosion.

The classical researches of Professor H. Dixon have shown that hydrocarbons and probably carbon burn in air to carbon monoxide, and that this carbon monoxide will not form explosive mixtures with air or even with oxygen if they are absolutely dry, but if water vapour is present they explode owing to the oxidation of the carbon monoxide to dioxide, causing the propagation of an explosive wave, which reaches its maximum velocity when the per-centage of water vapour is between 5 and 6 per cent., and inasmuch as the air of the mines would always contain some moisture, and as the products of combustion also would give a large volume of water vapour, these requirements would be amply fulfilled.

Still more conclusive on this point were Mr. Hall's experiments. In these you had a charge of blasting powder fired from a cannon suspended in the shaft the air of which was proved by careful chemical analysis to be absolutely free from any trace of combustible gas.

In order to get some idea of the condition of the air inside the pit during the explosion, samples of air were taken and were analysed. Two brass tubes, filled with water, were fastened to the rope that was used to lower the cannon, one twenty yards from the bottom, the other forty yards from the bottom.

These tubes were so arranged and constructed that the explosion, as it passed the tubes, unsealed the outlet pipe, and the escaping water sucked in a sample of air which was trapped by a special arrangement and kept in the tube until the rope could be wound up. By this method it was intended that the sample of gas taken should represent the state of the air whilst the flame was passing, or directly afterwards.

The tube nearest the bottom, as the analysis will show, did partly collect the gas in the above condition. The tube at the top, however, commenced to act prematurely, and was probably started by the sound wave which preceded the explosion. This tube simply contained ordinary air.

The following is an analysis of the gases found in the tube:—

	Per cent.
Oxygen	3·9
Nitrogen	75·9
Carbon dioxide	12·1
Carbon monoxide	8·1
	100·0

This ingenious arrangement was due to Mr. W. J. Orsman, and it is probably the first successful attempt which has been made to get a sample of gas during explosion, and there is not the slightest doubt that the presence of such an amount of carbon monoxide converts mixtures of coal dust and air into a highly explosive body.

As the explosion takes place, and as the carbon monoxide already produced is oxidised to carbon dioxide by the action upon it of water vapour present, and also by its direct combustion with oxygen, the hydrogen of the water vapour is set free, whilst the heated coal dust also yields certain inflammable products of distillation to the air, and partial combustion also of the coal dust gives a considerable proportion of carbon monoxide once more, and this, driven rapidly ahead of the explosion, forms, with more coal dust and air, a new explosive zone, and so, by waves and throbs, the explosion is carried through the dust-laden galleries of the mine.

The experiments made by Mr. Hall, and investigations in various colliery explosions, make it abundantly manifest that no explosive should be licensed for use in mines, unless it can be absolutely proved that it gives off no inflammable products of combustion. The following Table will show the results given by some of the explosives most largely used, which point very clearly to the fact that, with the exception of the Sprengel explosives, such as roburite, and nitroglycerine itself, none of the bodies in use conform to these important requirements:—

PRODUCTS OF COMBUSTION OF BLASTING EXPLOSIVES.

Powder.	Carbon dioxide.	Combustibles. Carbon monoxide.	Combustibles. Hydrogen and Marsh gas
Gunpowder	50·6	10·5	3·1
Blasting powder	30·1	33·7	7·9
Sprengel explosives—			
Roburite	32	Nil.	Nil.
Ammonite	33	Nil.	Nil.
Nitroglycerine explosives—			
Nitroglycerine	63	Nil.	Nil.
Gelignite	25	7	Nil.
Carbonite	19	15	26
Blasting powder	36·5	32·5	8·6
Nitrocotton explosive—			
Tonite	30	8	Nil.

Not only these considerations, but Mr. Hall's experiments, point to the absolute necessity for legislative enactments at once forbidding the use of blasting powder in any coal mines, no matter how free they may appear to be from firedamp or from dust. If we examine the returns made as to deaths caused by gunpowder and other explosives in mines for the year 1893, it will be clearly seen that the exclusion of gunpowder in handling alone would do away with 80 per cent. of the accidents.

Cause of Accident.	No. of Deaths.
Spark or flame	8
Premature explosion, hang-fire, &c.	8
Forcing into hole or breaking up	3
Unramming	0
Miscellaneous	1
	20
Deaths caused by other explosives, dynamite, gelignite, &c.	4

So that if explosives of the Sprengel class were employed, accidents due to the explosives used would be practically eliminated from the mining death-roll, and it is only a qnestion of time as to when England will follow the action of France and Germany in altogether prohibiting the use of blasting powder in dusty mines.

If legislative action can be stirred up on this important subject, and an Act be determined upon for the prohibition of dangerous explosives, it would be as well if another point intimately connected with safety in mines could be dealt with at the same time, and that is, the use of unprotected flames in many mines which have the reputation for being safe. In the South Wales district, candles are in use in some large collieries, and are generally employed in the house coal seams belonging to the smaller firms.

Most steam coal companies, also, work a house coal seam, which lies nearer to the surface than the steam coal, and the working takes place from a separate shaft; and even some large companies, who insist on lamps and safety explosives being used in working the steam coal, allow candles and gunpowder in the house coal seams.

Large outbursts of gas rarely, if ever, take place in the house coal, but, in the majority of cases, small quantities of gas escape from cracks in the roof, &c., and, as a rule, are swept away by good ventilation, unless the uneven character of the roof forms cavities in which small quantities of gas collect, and as the candles are carried by being stuck in a socket in the front of the miners' caps, they are in the position most suitable for igniting such collections of inflammable gas; and I am informed that cases are by no means infrequent in which the miner is badly burnt by a sudden puff of flame caused in this way, although no explosion in the mine may be generated. It is manifest that, however good the record of a mine may be, the use of naked flames is running a most unnecessary risk, and one which some day or other will result in a most serious disaster. Although it might increase the financial burden on some of the smaller mine owners, the use of blasting powder and naked flame ought to be at once put down.

The safety of such Sprengel explosives as roburite in handling and in use is, to a large extent, dependent upon the fact that when the mixture of ammonium nitrate and the nitrated organic body is ignited by ordinary flame, the ammonium nitrate requires a large amount of heat for its decomposition, in order to render the oxygen which it contains available for the combustion of the carbon and hydrogen in the organic body, and the temperature of the burning substance is not sufficiently high to propagate this action throughout the mass, the result being that to cause continued com-

bustion you must have a continuous supply of heat, or the flame first started simply dies out.

The effect of this is that in handling, such bodies are, practically, non-inflammable, and when they are made to explode by detonation, a more than usually powerful detonator has to be employed, so that, although with the nitro-glycerine mixtures a charge of 7 grains of mercuric fulminate is amply sufficient to produce detonation, such a body as roburite needs at least 15 grains. Moreover, when detonation has been produced, the amount of heat absorbed by the decomposition of the ammonium nitrate causes a very considerably lower temperature of explosion, as is shown in the following Table, which contrasts the temperatures developed by the more prominent explosives:—

	Degrees C.
Blasting gelatine	3,220
Nitroglycerine	3,170
Dynamite	2,940
Gun-cotton	2,650
Tonite	2,648
Picric acid	2,620
Roburite	2,100

The temperature at which mixtures of marsh gas and air ignite is between 650° and 700° C., and although the temperatures of explosion are so enormously high, they only occasionally ignite an inflammable mixture of the gases, this being due to the fact that in order to ignite firedamp, not only must the temperature of ignitition be reached, but it must be sustained for several seconds before the gases inflame, and as the explosion by detonation is instantaneous, ignition does not occur; if, however, some of the charge burns instead of detonating, the gaseous mixture is fired.

With mixtures of carbon monoxide and air, however, if coal dust be present, ignition takes place directly the required temperature is reached.

The last requirement of a perfect blasting powder is that it should emit no fumes which are noxious to health, and this brings us face to face with the question of the definition of the term "noxious." The complete products of combustion, which are inseparable from all explosives are carbon dioxide and water vapour, and I have heard people when in an excessively hypercritical condition of mind, allege that carbon dioxide should be classed amongst the fumes which are injurious to health, but I am inclined to deny this, although we all know perfectly well that the carbon dioxide present in the atmosphere in quantities much above 4 parts in 10,000 affect health, yet we are perfectly well aware also that it has no toxic effect upon the system, its action being to retard the interchange of oxygen and carbon dioxide in the blood by the process of diffusion in the lungs. The best proof that it has no practical poisonous effect on the system being that it is evolved by nearly all the functions of the body.

If we enter into an atmosphere of carbon dioxide death ensues within a few minutes, but is brought about in precisely the same way as if we had held our head under water for an equal length of time, and I have never yet heard of pure water being classed as a noxious substance.

The true noxious vapours are those which have a definite toxic action upon the system, and of these practically the only one evolved during explosion under pressure, or by detonation, is carbon monoxide; and a reference to the Table giving the products of combustion of the various substances will make it clear that those bodies which may be used with safety, as regards the risk of giving rise to an explosion in a dusty mine, are also free from danger in this respect.

It is not long since that a high authority on explosive matters regretted that there was not such a thing as an electric lamp which could be looked upon as perfectly safe for use in explosive factories, or in fiery mines, and in concluding my subject to-night, I should like to draw your attention to one which has been devised in order to meet these requirements, and which, having been exhaustively tested with regard to its safety, has been largely used at one of the South Metropolitan Gas Works, for such dangerous operations as cleaning the interior of gas-holders, tanks, purifiers, &c. It consists of an incandescent lamp mounted upon the end of a short glass tube. In the middle of the tube is sealed a platinum disc in such a way as to be gas tight. To the disc is attached a metal spring leading to one terminal, and the other terminal is connected to a wire which passes outside the glass tube, and is sealed into the outer enclosing glass envelope, which surrounds the whole of the lamp and half the glass tube, communication having been previously established between the interior of the tube and the outer envelope by means of a hole in the tube. In the outer half of the tube a platinum wire is inserted and adjusted in such a way that when air is forced into the outer envelope, the platinum disc is depressed and makes contact with

this wire. The lamp thus made consists of two gas-tight divisions separated by the disc. the larger one containing the lamp, one terminal, and half length of glass tube, the other and smaller one containing the platinum wire. Air, or an inert gas, under pressure is sealed up in the outer envelope, causing the disc to be depressed, thus making contact with the wire, and enabling the current to pass. If the outer envelope be broken the air escapes, the platform disc resumes its flat condition, and contact is broken, any sparking that may arise on the rupture of the current being confined to the smaller gas-tight division, thus obviating any risk of igniting inflammable gaseous mixtures. Instead of introducing air under pressure in the outer envelope, a vacuum may be formed, when the connections between the disc and wire will have to be altered accordingly.

In concluding this course of lectures, I extremely regret that the short time at my disposal has prevented me from touching upon many subjects which I should have liked to have gone into, such as fuses, detonators, and the relative safety of the different methods employed for firing a charge, and I can only hope that my audience have found some points of interest in my meagre attempt to interest them in the modern development of explosives.

SIXTH ORDINARY MEETING.

Wednesday, January 16th, 1895; WILLIAM ANDERSON, D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Abbott, George Herbert, 115, Portland-street, Southport.
Browne, Robert Jamieson, Howrah Dock, Howrah, Calcutta.
Becks, George Arthur, The Broadway Testing Works, Westminster, S.W.
Clarke, Charles Henry, LL.D., 2, Rutland-terrace, High-road, Leyton, Essex.
Emerson, P. H., B.A., M.B. (Cantab), Arlingbold, Broadstairs, Kent.
Hampton, George, 8, Pall-mall East, S.W., and 1, Cockspur-street, S.W.
Hayashi, Gonsuké, Japanese Consulate, 84, Bishopsgate-street Within, E.C.
Heath, Commendatore Henry Burnley, 31, Old Jewry, E.C.
Hirst, William, 9, Gracechurch-street, E.C.
Hopekirk, Walter, Crystal Palace, Upper Norwood, S.E.
Knighton, William, LL.D., Tileworth, St. Leonards-on-Sea.
Langsford, John, 12, Soho-square, W.
Lawson, Archibald, Baker-street, Weybridge, Surrey.
Lewis, T. Lawrence, Local Board of Health, St. George, near Bristol.
Mathewson, Jeremiah Eugene, Tilghman's Patent Sand Blast Company, Bellefield Works, Sheffield.
Meath, Earl of, 83, Lancaster-gate, W., and Killruddery, Bray, Co. Wicklow.
Messer, Frederick Alfred, 8, Quality-court, Chancery-lane, W.C.
Pell, Bennett, 6, Granville-park, Blackheath, S.E.
Saunders, Ernest William, 19, Vicar-lane, Leeds.
Winmill, Hallett, care of Charles C. Winmill, Main-road, Bexley-heath, and Barberton, South Africa.

The following candidates were balloted for and duly elected members of the Society:—

Barth, Frederick Alfred, 47, King-square, E.C.
Copus, George, Halstead, Essex.
Gammell, Hector Hatch, Birnbeck-house, Weston-super-Mare.
Hales, William, 29, Birdhurst-rise, Croydon.
Holmes, William, 18, Cicada-road, Wandsworth-common, S.W.
Parry, William Kaye, M.A., 35, Dame-street, Dublin, and 6, Charlemont-terrace, Kingstown.
Smith, T. Walrond, 137, Victoria-street, S.W.
Willis, John, Stansfield, Clewer, Windsor.
Woodward, Edward Francis, 43, Southwell-street, Bristol.

The paper read was—

THE COMMERCIAL SYNTHESIS OF ILLUMINATING HYDROCARBONS.

By PROFESSOR VIVIAN B. LEWES.

The two methods most used in chemical science for tracing the changes taking place in matter, and determining the composition of bodies, are, firstly, the breaking up of compounds into their ultimate constituents, a process which is called "analysis;" and, secondly, the building up of the compound from the elementary matter which forms it, a process to which the name of "synthesis" has been given.

If we take chalk and heat it in the limekiln, or in the chemist's crucible, a heavy, colourless gas, called carbon dioxide, escapes from it, and leaves behind a substance which we know as quicklime. If, now, this quicklime be further acted upon by chemical methods, it can be shown to contain the metal calcium and the elementary gas oxygen, whilst the carbon dioxide when collected can be decom-

posed into the elements carbon and oxygen, and by such a series of operations as this we might perform the analysis of chalk.

If now we start with the metal calcium, with carbon, and with oxygen, it is perfectly simple to reverse the operation, and rebuild the chalk molecules from these elementary forms of matter; by burning the carbon and calcium respectively in oxygen, we obtain the quicklime and the carbon dioxide, and by bringing these substances together in the presence of moisture, chalk or calcic carbonate is once more formed, and we have synthetically built up the chalk from its constituents.

By such simple methods as these most inorganic compounds can be synthetically produced from elementary matter, but in the so-called organic chemistry it is not so easy to employ such constructive methods for the formation of compounds. Up to the end of the first quarter of this century it was supposed that organic bodies were only produced as the result of animal and vegetable life, and that their formation was due to the so-called "vital force," which was credited with governing all changes taking place in living organisms.

In 1828, Wöhler showed that urea could be formed from cyanate of ammonium, whilst, later on, Fownes made cyanogen by the direct combination of carbon and nitrogen, these two discoveries taken together proving the possibility of forming an organic product from inorganic materials; and after this point had been reached, and the possibility of applying synthetic methods to the production of organic bodies had been demonstrated, compound after compound was built up without the aid of either vegetable or animal life, and the barrier between inorganic and organic chemistry finally broken down. Cases, however, in which such methods could be commercially successful were few and far between, as in most cases the processes which had to be adopted were costly and laborious.

In all the phenomena of ordinary combustion which we employ to provide us with heat and light, there are no compounds of greater interest than the class of organic bodies which, being formed of carbon and hydrogen in various proportions, have been termed hydrocarbons, and it is to this class of bodies that all the gases which can be used as ordinary illuminants owe their luminosity. Amongst the hydrocarbons, the simplest compound is acetylene, in which two atoms of carbon are united with two atoms of hydrogen; and it has long been known that, if a stream of hydrogen is passed through a globe in which the voltaic arc is produced between carbon points from a sufficiently powerful current, this gas is produced in minute quantities. It can also be formed in small quantities by the decomposition of carbon tetrachloride in the presence of hydrogen by the induction spark, whilst it is produced during processes of checked combustion in hydrocarbon flames.

The direct combination of carbon and hydrogen in the electric arc is a true case of synthesis, and if we could form acetylene in this way in sufficiently large quantities, it would be perfectly easy to build up from the acetylene the whole of the other hydrocarbons which can be used for illuminating purposes. For instance, if acetylene be passed through a tube heated to just visible redness, it is rapidly and readily converted into benzol; at a higher temperature naphthalene is produced, whilst by the action of nascent hydrogen on acetylene, ethylene and ethane can be built up. From the benzol we readily derive aniline, and the whole of that magnificent series of colouring matters which have gladdened the heart of the fair portion of the community during the past five and twenty years, whilst the ethylene produced from acetylene can be readily converted into ethyl alcohol, by consecutively treating it with sulphuric acid and water, and from the alcohol, again, an enormous number of other organic substances can be produced. Thus acetylene can, without exaggeration, be looked upon as one of the great keystones of the organic edifice, and, given a cheap and easy method of preparing it, it is hardly possible to foresee the results which will be ultimately produced.

From acetylene we can produce all those bodies which we are accustomed to look upon as the most important ones in our coal-gas, and which, up to the present time, have never been produced from anything but coal, hydrocarbon oils, or other organic matter undergoing destructive distillation, but it has often occurred to those of us who are interested in the manufacture of illuminating gas, that as the supply of coal gets smaller, and as oil in time begins to share the same fate, some new sources for our illuminants and our fuels must be sought; and in my mind, at any rate, the synthetic production of hydrocarbons has long been a day dream, which I, however, never expected to see possible on a commercial scale.

Not only was the synthetic production of

acetylene in the electric arc well known, but ever since water-gas has been introduced, small traces of acetylene and methane have been found in it under conditions which render it impossible that they should have been produced from any compound present in the incandescent fuel. They must, therefore, have been due to the direct combination of carbon and hydrogen, but these traces only occurred in quantities so small as rarely to amount to one per cent., and it was manifest that the production of the compounds could not take place in large quantities under influences which would immediately tend to decompose them.

In 1836, it was found that when making potassium, by distillation from potassic carbonate and carbon, small quantities of a bye-product, consisting of a compound of potassium and carbon were produced, and that this was decomposed by water with liberation of acetylene; whilst Wöhler, by fusing an alloy of zinc and calcium with carbon made calcic carbide, and used it as a source from which to obtain acetylene by the action of water.

Nothing more was done until 1892, when Macquenne prepared barium carbide by heating at a high temperature a mixture of barium carbonate, powdered magnesium, and charcoal, the resulting mass evolving acetylene, when treated with water; whilst, still later, Travers made calcic carbide by heating together calcic chloride, carbon, and sodium. None of these processes, however, gave any commercial promise, as the costly nature of the potassium, sodium, magnesium, or zinc-calcium alloy, which had to be used, made the acetylene produced from the carbide too expensive.

It is now some 25 years ago since I listened to one of the Friday evening lectures at the Royal Institution, given by Mr. Greville Williams, and in the same way that the thread of some melody lingers in one's mind, so has the concluding sentence of that lecture constantly recurred with ever-increasing force—"The impossible is a horizon which recedes as we advance; and the *terra incognita* of to-day will to-morrow be boldly mapped upon every schoolboy's chart." The haunting dream of the possibility of synthesising hydrocarbons commercially has, with the onward march of science, to-day become an accomplished fact.

As is so usual in the history of discovery, the factor which has endowed us with the power of doing this was not the outcome of an elaborate research, having this discovery fo its ultimate goal, but was found by chance during the search for another object.

Whilst working with an electric furnace, and endeavouring by its aid to form an alloy of calcium from some of its compounds, Mr. T. L. Willson noticed that a mixture containing lime and powdered anthracite, under the influence of the temperature of the arc, fused down to a heavy semi-metallic mass, which having been examined, and found not to be the substance sought, was thrown into a bucket containing water, with the result that violent effervescence of the water marked the rapid evolution of a gas, the overwhelming odour of which enforced attention to its presence, and which, on the application of a light, burnt with a smoky, but luminous flame.

Investigation into the cause of this phenomenon soon showed that in a properly constructed electric furnace, finely ground up chalk or lime, mixed with powdered carbon in any form, whether it were charcoal, anthracite, coke, coal, or graphite, can be fused with the formation of the compound known as calcic carbide, containing 40 parts by weight of the element calcium, the basis of lime, and 24 parts by weight of carbon, and that, on the addition to this of water, a double decomposition takes place, the oxygen of the water combining with the calcium of the calcic carbide to form calcic oxide or lime, whilst the hydrogen unites with the carbon of the calcic carbide to form acetylene, the cost of the gas so produced bringing it not only within the range of commercial possibilities for use *per se*, but also the building up from it of a host of other compounds, whilst the production of the calcic carbide from chalk and from any form of carbon, renders us practically independent of coal and oil, and places in our hands the prime factor by which Nature in all probability produces those great underground storehouses of liquid fuel upon which the world is so largely drawing to-day.

Wonderfully and intensely interesting as is the train of thought opened up by the discovery of this substance and its commercial production, the object I have in view this evening is not to discuss theoretic possibilities, but to show you the important effect which it will have in the direction of our great gas industry, and the phase of this which I wish to deal with specially is the value of acetylene, either for producing *per se* an enormously high illuminating effect, or for the enrichment of low grade coal-gas.

When the calcic carbide is placed in a glass

flask, and water allowed to slowly drip upon it from a dropping tube, the decomposition at once commences with considerable rapidity, and the acetylene pours off in a continuous stream; as the decomposition continues, the solid mass in the flask swells up, and is eventually converted into a mass of slaked lime.

Calcic carbide is a dark grey substance, having a specific gravity of 2·262, and, when pure, a pound of it will yield on decomposition 5·3 cubic feet of acetylene. Unless, however, it is quite fresh, or means have been taken to carefully protect it from air, the outer surface gets slightly acted upon by atmospheric moisture, so that in practice the yield would not exceed five cubic feet. The density and hardness of the mass, however, protects it to a great extent from atmospheric action, so that in lumps it does not deteriorate as fast as would be expected, but in the powdered condition it is rapidly acted upon.

For commercial purposes the carbide will be cast direct from the electric furnace into rods or cylindrical cartridges, which, when 12 inches long and $1\frac{1}{4}$ inches in diameter, will weigh one pound, and will give five cubic feet of gas.

The acetylene so made, when analysed by absorption with bromine, the analysis being also checked by determining the amount present by precipitation of silver acetylide, gives 98 per cent. of acetylene, and 2 per cent. of air, and traces of sulphuretted hydrogen, the presence of this impurity being due to traces of sulphate of lime—gypsum—in the chalk used for making it, and to pyrites in the coal employed.

Acetylene is a clear, colourless gas with an intensely penetrating odour which somewhat resembles garlic, its strong smell being a very great safeguard in its use, as the smallest leakage would be at once detected; indeed, so pungent is this odour, that it would be practically impossible to go into a room which contained any dangerous quantity of the gas.

This is an important point to remember, as the researches of Bistrow and Liebreich show that the gas is poisonous, combining with the hæmoglobin of the blood to form a compound similar to that produced by carbon monoxide, whilst the great danger of the latter gas is that having no smell, its presence is not detected until symptoms of poisoning begin to show themselves, so that no fear need be apprehended of danger from this source with acetylene.

Acetylene is soluble in water and most other liquids, and at ordinary temperature and pressure—60° Fahr., and 30 inches of mercury—10 volumes of water will absorb 11 volumes of the gas, but as soon as the gas is dissolved, the water being saturated takes up no more. Water already saturated with coal-gas does not take up acetylene quite so readily, whilst the gas is practically insoluble in saturated brine—100 volumes of a saturated salt solution only dissolving 5 volumes of the gas. The gas is far more soluble in alcohol, which at normal temperature and pressure takes up six times its own volume of the acetylene, whilst 10 volumes of paraffin under the same conditions will absorb 26 volumes of the gas. It is a heavy gas, having a specific gravity of 0·91.

When a light is applied to acetylene, it burns with a luminous and intensely smoky flame, and when a mixture of 1 volume of acetylene with 1 volume of air is ignited in a cylinder, a dull red flame runs down the cylinder, leaving behind a mass of soot and throwing out a dense black smoke. When acetylene is mixed with 1·25 times its own volume of air, the mixture begins to be slightly explosive, the explosive violence increasing until it reaches a maximum with about twelve times its volume of air, and gradually decreases in violence until, with a mixture of 1 volume of acetylene to 20 of air, it ceases to be explosive.

The gas can be condensed to a liquid by pressure, Ansell finding that it liquefied at a pressure of 21·5 atmospheres, at a temperature of 0° C., whilst Cailletet found that at 1° C., it required a pressure of 48 atmospheres, the first-named pressure being probably the correct one. The liquid so produced is mobile, and highly refractive, and when sprayed into air, the conversion of the liquid into the gaseous condition, absorbs so much heat that some of the escaping liquid is converted into a snow-like solid, which catches fire on applying a light to it, and burns until the solid is all converted into gas and is consumed.

In my researches upon the luminosity of flame, I have shown that all the hydrocarbons present in coal-gas and other luminous flames are converted by the baking action taking place in the inner non-luminous zone of the flame into acetylene before any luminosity is produced, and that it is the acetylene which by its rapid decomposition at 1,200° C. provides the luminous flame with those carbon particles, which, being heated to incandescence by various causes, endow the flame with the

power of emitting light. The acetylene, being in this way proved to be the cause of luminosity, one would expect that in this gas we have the most powerful of the gaseous hydrocarbon illuminants; and experiment at once shows that this is the case.

Owing to its intense richness, it can only be consumed in small flat-flame burners, but under these conditions emits a light greater than that given by any other known gas, its illuminating value calculated to a consumption of 5 cubic feet an hour being no less than 240 candles.

Illuminating Power of Hydrocarbons for a Consumption of 5 *cubic feet of Gas.*

	Candles.
Methane	5·2
Ethane	35·7
Propane	56·7
Eythelene	70·0
Butylene	123·0
Acetylene	240·0

Having arrived at this startling result, it will be as well to at once turn to the commercial aspect of the problem, as it is upon this that the utilisation of this magnificent illuminant is entirely dependent. At the present time, private information from America shows that calcic carbide can be produced at a little under £4 a ton, and the beautifully pure lime obtained by the decomposition would be worth to the gas manager at least 10s. a ton; and as a ton of the carbide will give rather more than 1¼ tons of quicklime or 1¾ tons of slaked lime, £3 10s. may be taken as the cost of the acetylene produced from a ton of the material, and will leave a margin for handling. A ton of the carbide will yield in practical working 11,000 cubic feet of acetylene, which will bring the cost of the gas out at 6s. 4½d. per 1,000.

The cheapest and best enrichment process known at the present time is that introduced by Mr. Young, and which has been adopted at a number of gas works in Scotland and the north of England. In this process, by special methods of retorting, oils are decomposed to yield a rich gas, which, in the photometer, and burnt in suitable burners *per se*, gives an illuminating value of about 60 candles, but for which an enrichment value of 96 candles is claimed.

I am desirous of understating rather than overstating the powers of the acetylene, so that, instead of taking enrichment values for it which might be questioned, I prefer to simply take the illuminating power of the gas when burnt, *per se*, and the light measured in the photometer, which, as before stated, is 240 candles, whilst, for the same reason, we will take the claimed enrichment value of the Young gas, instead of its photometric value.

An extended experience, gained with the Young process, as used at St. Helen's for the enrichment of coal-gas, shows that the cost may be taken at 3s. 4d. per 1,000 cubic feet. If now we compare this with the acetylene at 6s. 4½d. per 1,000, we find that the 240-candle gas at this price would be equal to Young gas at 2s. 6½d. Moreover, the Young plant, to work a ton of oil per diem, costs—according to the experience at Peebles—£1,500, and generates 22,000 cubic feet a day, the retorts for this purpose occupying a very considerable space; whilst, to make the same volume of acetylene, two tons of material would have to be handled, and the whole operation could easily be carried out in one small egg-ended boiler, fitted with an automatic water feed, and automatic gas delivery valve to outlet of the main for the holder, so that the enriching gas could be added *pro rata* to the gas as it left the works in order to bring it up to any required strength, in the same way as is done with the Maxim-Clarke enrichment, and all the troubles of stratification in the holder would be done away with. For the first few hours, the water in the consumers' meters would absorb small quantities of the acetylene, but quickly becoming saturated, no further absorption would take place.

It is well known that acetylene forms two compounds with ammoniacal solutions of the metals silver and copper, and both of these compounds, when dry, can be readily exploded by percussion, friction, or heat. In the early days of gas supply, copper pipes were used in New York, and Torrey, in 1839, found in them a brown scaley deposit, which exploded when struck or heated to 200° C., and which was, in all probability, acetylide of copper.

An extended series of experiments on this point show that when metals are kept in the gas, even if moisture be present, no action takes place unless water condenses on the metal, when tarnishing with silver and copper, and to a less degree with brass, commences, and under these conditions, an acetylide of mercury can also be formed, but the other metals remain unacted upon. If, therefore, iron, tin, lead, or compo pipes be used for the gas supply, no precautions are necessary. Copper and brass tubes must either be coated inside with some varnish not acted upon by the acetylene, or tin lined.

In America, which was the birthplace of this method of making calcic carbide, the acetylene is mixed with an equal volume of air, and the mixture burnt at small slit burners; but I confess to a grave mistrust of this method of using the gas, as the margin of safety in the amount of air required to convert the mixture into an explosive is so small that the danger of exceeding it on any large scale must be very great, as any mistake or alteration in the mixing apparatus used for this purpose might easily bring the per-centage of air up to the explosive limit, whilst the diluting action of the nitrogen of the air reduces the illuminating value of the acetylene present from 240 candles to 130.

The possibility of liquefying acetylene by pressures about those at which liquid carbon dioxide is produced so largely, enables enormous volumes of this gas to be compressed into the liquid state in small wrought iron or steel cylinders, and in this condition, by means of suitable reducing valves and burners of the right construction, it may be stored and burnt. Used in this way, it will be of the greatest possible value for floating buoys, and the small cylinders can also be arranged in the form of portable lamps, whilst for use in the country, where no gas is available, a large cylinder of the liquid gas placed in an outhouse would supply a country house with light for a very long period; and there is no doubt that there is a very great field for it in this direction, as by utilising suitable burners a consumption of half a cubic foot an hour will give a light equal to from 20 to 25 candles.

Perhaps the most valuable suggestion which has been made with regard to the utilisation of this remarkable method of making acetylene is, that advantage should be taken of the method of preparation to utilise the of body portable lamps for dining and drawing-rooms in places where no gas supply exists. To do this a strong steel cylinder, 4 inches in diameter and 16 inches in length, is fitted with an opening in the top of such size that a pound cartridge, or stick of the calcic carbide, can be passed through it. The cylinder has a second opening at the bottom, closed by a screw, for cleaning out the lime left by the decomposition. The right proportion of water is put into the cylinder, and the stick of carbide, coated with a slowly soluble glaze, is inserted and the head of the lamp screwed on. This head contains a double reducing pressure valve, which brings down the pressure existing in the cylinder to that necessary for the proper consumption of the gas, it also being fitted with a valve. As the glaze dissolves from the surface of the stick of carbide, acetylene is generated, and the five cubic feet are compressed by their own pressure, the cylinder being placed in a vessel of cold water whilst the gas is generating, and the gas can then be burned from a suitable jet at the rate of half a cubic foot per hour, which will give a light of over 20 candles for something like 10 hours. When the gas is all burnt out from the cylinder the top of the lamp is screwed off, the bottom plug also removed, and the lime washed out from the interior of the cylinder by a rapid stream of water. The cylinder is then recharged as before. Used in this way also, this gas would rapidly replace oil gas for railway lighting, as the fittings at present in use for the Pope and Pintsch systems would answer perfectly well for the purpose of using acetylene, the only difference being that the cylinder placed below the carriage, which, under the present conditions, is filled with compressed oil gas, would be utilised, not only as a storing, but as a generating vessel for the acetylene, the highly-expensive oil gas manufacturing and pumping plant being done away with, and a magnificent illumination ensured in the carriage.

Of late years, an idea has been slowly permeating the minds of some gas managers in this country that it might be well to adopt a dual gas supply, one for fuel purposes, which would consist of a poor coal-gas of about 12 candles, whilst the gas for illuminating purposes would be of about 20 candles; and in one town, at least, it has been proposed, and, I believe, carried out, that a supply of poor quality coal-gas should be sent out during the day, when the maximum consumption is for heating purposes, and a richer gas at night for illuminating purposes, utilising the same mains for both. Although this is possible in a small town where the area to be supplied is not large, it would be impossible in a big town where many miles of huge mains have to be travelled before certain districts are reached, and the cost of a double set of mains would render a dual supply an impossibility.

The use of acetylene would render it possible for the gas company to send out a 12-candle gas for heating purposes, both by night and day, whilst a small enrichment cylinder might be attached to the gas outlet pipes from the consumer's meter, and this would be made

to automatically enrich the gas supplied to his house, so that by setting a valve he could have any quality he might desire.

The economic value of an illuminant such as acetylene becomes apparent, when we compare the cost of the gas for equal illumination with the light obtained from other illuminants. The London gas has an illuminating power of 16 candles, whilst the acetylene has an illuminating value of 240 candles, and this, at 6s. 4½d. per 1,000, would in light-giving value be equivalent to London coal-gas at less than 6d. per 1,000.

In order to obtain a given illumination, moreover, the volume of gas to be consumed is excessively small, as compared with any other illuminating gas, and the products of combustion are reduced to an excessively low limit. One hundred cubic feet of London coal-gas will yield 50 cubic feet of carbon dioxide, and 140 cubic feet of water vapour, as the products of its complete combustion, whilst 100 cubic feet of acetylene would yield 200 feet of carbon dioxide and 100 feet of water vapour. The acetylene, however, in its combustion, gives a light of 240 candles, as against 16 yielded by the coal-gas; and for equal illumination, therefore, the amount of carbon dioxide and water vapour produced is enormously smaller.

The following Table contrasts the products of combustion evolved from London coal-gas, when consumed in various forms of burners, and giving an illumination of 48 candles, which may be presumed to be the amount of light required in a fair-sized London dining-room, and contrasted with this is the amount of the products of combustion which acetylene would evolve in giving the same amount of light; whilst to make the meaning clearer, I have added the number of adults who would exhale the same amount of carbon dioxide in the same time.

Burner.	Gas consumed.	Carbon dioxide produced.	Adults.
Flat flame, No. 6..	19·2	10·1	16·8
Flat flame, No. 5..	22·9	12·1	20·1
Flat flame, No. 4..	25·3	13·4	22·3
London Argand ..	15·0	7·9	13·1
Acetylene	1·0	2·0	3·6

If we obtained the same amount of light from paraffin lamps, the carbon dioxide evolved would be equivalent to 22·5 adults; whilst as far as carbon dioxide goes, you might as well invite 32·7 guests to dinner as use 48 sperm candles to supply the needed illumination.

The flame of acetylene, in spite of its high illuminating value, is a distinctly cool flame, and in experiments which I have made by means of the Le Chatelier thermo-couple, the highest temperature in any part of the flame is a trace under 1,000° C., whilst with coal-gas burning in the same way in a flat-flame burner, the temperature rises as high as 1,360° C. If the heating effect of the flames be contrasted for equal illumination, it will be seen that the acetylene flame has so small a heating effect, considering its area, that it would not be much greater than the ordinary electric incandescent lamp.

The intensity of the light will make small acetylene lamps of enormous value for lantern projection, for railway signals, and, coming down to smaller things, bicycle lamps, whilst I should imagine the ease of production specially adapts it for such purposes as lighthouse illumination.

The scope and possibilities of such a discovery as that which I have brought before you this evening cannot be realised until many factors, at present unknown, are thoroughly worked out, and you must remember also that the time at my disposal has only enabled me to bring before you to-night some facts connected with the light-giving value of this hydrocarbon, and that, as a stepping-stone to the synthesis of other bodies, its value will be incalculable. One cannot help feeling that as science grows, and as our grasp and comprehension of the marvellous processes by which Nature builds up her matter become more and more extended, synthesis may have even greater conquests to make than the mere building up on a commercial scale of an illuminating hydrocarbon.

We are beginning to realise more and more fully the marvellous way in which Nature keeps matter in circulation, the way in which animal and vegetable structures are built up from the simplest and most plentiful substances, and the way in which, when the structure is done with, those processes of slow combustion, which we call decay, again convert the waste bodies into carbon dioxide and water vapour, from which once more Nature reconstructs the vegetable and animal kingdom; and it may be that as our perception of the methods of that marvellous natural architecture gets clearer and keener, we may dis-

cover how, by simple synthetic processes, the carbon dioxide and water vapour, which form Nature's building material, may be synthetically utilised by us in building up, not the perfected form of man, or animal, or plant, but the building on a commercial scale of the food which is required by Nature for carrying on the functions necessary for life.

DISCUSSION.

Mr. Lewis G. Wright said this paper was of much interest to technical men, in two points of view, because most of them had an interest in both the scientific and commercial side of any such process as had been described. He would ask whether it had been proved by experiment that the high luminosity of acetylene was retained when mixed with coal-gas as an enricher, to the same extent as it showed when burned in the pure condition? Many, perhaps, might think that such would necessarily be the case, but he had reason to know that in mixtures of gases the luminosity was not always the arithmetical mean of that of the gases employed.

Mr. William Sugg said the whole thing was so surprising, that it was very difficult to offer any remarks upon it. He was much struck with the fact that this gas appeared to have such a strong affinity for oxygen. It was generally found very difficult, in burning a very rich gas, to provide it with a sufficient quantity of oxygen from the air to produce a brilliant light; but this appeared to burn as brightly almost as if it were in an atmosphere of oxygen. There did not appear to be anything very special about the burner, and therefore he gathered that the gas must have a powerful affinity for oxygen. The manufacture of the gas appeared so simple, that probably most of those present thought they could do it straight off, but possibly some difficulties might crop up in practice.

Mr. C. C. Carpenter (Southwark and Vauxhall Gas Company), said he must congratulate Professor Lewes on this sequel to his well-known researches into the effect of acetylene on the luminosity of gas. He should also like to emphasize the point raised by Mr. L. Wright with regard to the enriching power of acetylene. Another point which occurred to him was with reference to the production of the calcic carbide at the price mentioned; it seemed to him that that was very low for an article which could only be manufactured by the electric furnace, and he should be glad to know if any light could be thrown on the method of producing the electricity which formed the carbide. The whole thing hinged on the commercial aspect, and that depended on the cost of the material. At any rate he thought Professor Lewes had done something which would be a great relief to the electric light engineer, as he would be able to get a level load line by making an article which would serve for the manufacture of gas.

Mr. T. S. Lacey said many people thought the Young process should be more largely adopted by gas companies, on account of the cheapness of the gas produced; but with a rich gas, such as was made in London, the amount of enrichment was but a small per-centage of the total value of the light, and that portion varied considerably. Sometimes you had to add one candle, sometimes two, sometimes half, and sometimes nothing, and the result was you were obliged to have a plant equal to the maximum enrichment, which was equal to the use of 10 or 15 per cent. of cannel; that meant a very large capital outlay. Any plan, therefore, which removed the necessity of such outlay was of great importance.

Mr. J. W. Helps said the paper had been very interesting and he hoped it would prove of great value to the gas industry. Professor Lewes said that acetylene would be used for enrichment much in the same way as the Maxim-Clarke process, *i.e.*, it would be applied to the gas after it left the holders, and he should like to know if it would have any effect on the absorption of napthalene, in which direction some enriching methods were found to be useful. He also thought the cost of the carbide was very low for an electric furnace product, and should like to know if the figures given were not based on electricity produced by water power.

Mr. Frank Mead said the paper had been quite a novelty to those connected with the gas industry, and was of intense interest. The main point, no doubt, in the commercial aspect was the cost of the carbide. If it were produced as a by-product, one could understand its being sold at a low price; but could it be produced at £4 a ton if an electric furnace were employed for that sole purpose? If the process were generally adopted, the quantity required would be very large, and what effect that would have on the price it was rather difficult to say. This gas, when unburned, was said to have a remarkably unpleasant odour, which would make its presence evident, and prevent danger; but he would ask if there were any odour when it was burned. He did not see any reason why there should be an odour from its combustion, but the point deserved attention. Again, as there was a great difference between the specific gravity of this acetylene and that of ordinary coal-gas, he thought there might possibly be layering of the two gases when mixed. The mixture with the gas as it went away from the holder was, of course, a different thing from mixing the enricher with the gas in the holder.

Mr. Frank Wright said it was very gratify-

ing to find that electricity was, to some extent, trying to befriend gas, as in certain instances the reverse had been the case. He should like to ask Professor Lewes if he had any information as to the candle-power to be obtained by this gas per horse-power of electrical energy, because, it seemed to him, it would hinge on that. If the gas companies did not take it up, the electrical concerns might work it round in a happy cycle of synthesis and analysis.

Mr. H. O'CONNOR asked what would be the effect of mixing acetylene with water-gas. If it did not produce an explosive mixture, the smell given off by the acetylene might give to water-gas the much-needed quality of notifying its presence when escaping.

Mr. R. MANUEL asked if there would be any danger of an explosion if an escape of acetylene took place in a room, and a person afterwards went in with a naked light, and if so, would it be more severe than an ordinary gas explosion?

Professor LEWES, in reply, said when he saw Mr. Lewis Wright get up, he fully expected to hear a question directed to some vital point. The question of enrichment was one of the most complex one could deal with; and enrichers varied to an extraordinary extent. An enrichment curve was never a nice, even curve, in which 1, 2, or 3 per cent. increased the illuminating value in proper proportion. You always had a curve rather flat at the bottom, and then gradually increasing up to the proper point. He was at present working out the enrichment values of a large number of pure hydrocarbons and mixtures, and was gradually getting to the bottom of the secret, but those results must be reserved for another paper. He might say, however, that when acetylene was added in small quantities to coal gas the enrichment value was about 1½ candles per cent. at the bottom of the curve, and went up fairly rapidly until you got to 50 candles, when it was at about its maximum. It was the same with ethylene, ethane, and several others. For water gas, however, it was of hardly any value as an enricher. If you took pure water gas, consisting of carbon monoxide and hydrogen, with small traces of impurities, 10 per cent. of the acetylene mixed with it gave a non-luminous flame; he knew the reason of that, and it made it absolutely useless for the enrichment of gas of that character. The same thing was found by Dr. Percy Frankland with ethylene. The burning question, next to that of enrichment, was the price of the carbide. He believed the experiments quoted in America, from which the price of 15 dollars was obtained, were made with electricity derived from water power; but there was another point to be borne in mind. Acetylene was not only a benefactor to the gas world but it might be a benefactor to the electric world. The big installations which were erected for lighting purposes could only use their plant for about one-fifth of the day, and they were trying to make dividends in the face of that obstacle. They all knew what happened to plant which stood still for four-fifths of its life, and he ventured to think that when there was a market for calcic carbide many of the big producing stations would look upon it as a help rather than enemy. If electric lighting were all in the hands of one Corporation they might think it worth while to try and stifle this, if they thought it was going, from its illuminating value, to interfere with them, but there were many Corporations all struggling to show good returns, and if they could use the leads from the dynamos for an electric furnace during daylight and for the generation of light during the night, there need be no fear of getting a sufficient supply of electricity for this purpose at a reasonable price. In reply to Mr. Sugg, he might say that the luminosity of a flame was not due entirely to the affinity of hydrocarbons for oxygen; it depended on exceedingly complex chemical reactions, of which a few only had yet been thoroughly worked out; and in fact the acetylene flame, though so brilliant as to suggest the highest incandescence, was far cooler than that of an ordinary gas burner. The temperature of an ordinary 16-candle gas flame in some parts rose as high as 1,400° C.; but no part of the acetylene flame was much over 900° C.; there was no overheating of the room, and the products of combustion were not noxious. If there were incomplete combustion the flame would smoke so badly that you would have to turn it out; and with such incomplete combustion only would there be any smell. The products would be the same as from the complete combustion of coal-gas—carbon dioxide, and water vapour. The plan he should recommend, in using acetylene as an enricher, would be to introduce it by a regular flow into the outlet main. Mr. Lacy raised an important point with regard to enrichment. In London there was a monstrous waste of enrichment, and the gas was sent out considerably above the statutory limits, in order to avoid any chance of a change of temperature bringing down the illuminating power, and so rendering the company liable to penalties. There ought not to be that necessity, and any process which required such a large margin was a wrong process. They needed that margin because they employed vapours to a considerable extent, and had to allow for skin friction in the mains, which was more important even than cold, in bringing them out again. If acetylene were used, the gas might be sent out at 16·4 or 16·5 candles, and there would not be any chance of its losing its illuminating power, because they would be dealing, not with a vapour, but with a fixed gas. Acetylene would have no effect on naphthalene. The vapour of liquids had somewhat the solvent effect that the liquids themselves had, and that was why the vapours of some of the light hydrocarbon

oils dissolved and moved on the naphthalene. He should put the relation between candle-power and electrical horse-power in this way; the light obtained from one horse-power of electric energy, by means of an incandescent lamp, might be put at 28, and by means of the production of calcic carbide and acetylene at 44.

The CHAIRMAN, in proposing a hearty vote of thanks to Professor Lewes, said they were much indebted to him for showing how an ornamental gas works might be constructed, apparently at much less cost than the present structures, which by no stretch of imagination could be called ornamental. Another thing that struck him was that they seemed to be getting very near that great desideratum in electrical engineering, a level load line, by means of a new form of storage battery. The electric energy in the furnace came out in the form of a stick which could be carried about, and would give a certain quantity of brilliant light, whenever you put it into water; so that really it was a case of storage of electricity in an extremely convenient form. It appeared to him not at all impracticable that, after all, the best way of utilising electricity would be to convert it into light by the method which had been exhibited that evening.

The vote of thanks was carried unanimously.

General Notes.

SANITARY INSTITUTE.—The Nineteenth Course of Lectures and Demonstrations for Sanitary Officers, held at the Parkes Museum, will commence on February 1st, and be continued on Tuesday and Friday evenings, at 8 p.m., until April 26th. Twenty-four lectures will be delivered on Physics and Chemistry, Bacteriology, Ventilation, Warming and Lighting, Sanitary Law, Food Supply, Water Supply, Infectious Diseases, Sanitary Building Construction, Sewerage, Scavenging, &c., &c. The lectures will deal with subjects scheduled for the examinations of the Institute.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

JANUARY 23.—"Tea." By A. G. STANTON. SIR ALEXANDER WILSON will preside.

JANUARY 30.—"Peking." By THOMAS CHILD. PROFESSOR ROBERT K. DOUGLAS will preside.

FEBRUARY 6.—"The Labour Question in the Colonies and Foreign Countries." By GEOFFREY DRAGE. The DUKE of DEVONSHIRE, K.G., will preside.

FEBRUARY 13.—"Light Railways." By W. M. ACWORTH. SIR BENJAMIN BAKER, K.C.M.G., F.R.S., will preside.

FEBRUARY 20.—"Rule of the Road at Sea." By ADMIRAL P. H. COLOMB.

Papers the dates of which are not fixed :—

"The Use of Aluminium in the Separation of Metals from their Oxides." By PROFESSOR WILLIAM CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. CHARLETON, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. CROMPTON, M,I.E.E.

"Electric Lighting of Ecclesiastical Buildings." By MAJOR-GENERAL CHARLES E. WEBBER, C.B.

"Our Food Supply from Australasia." By E. MONTAGUE NELSON.

"Cider." By C. W. RADCLIFFE COOKE, M.P.

"Improvements in Milling Machinery." By J. HARRISON CARTER.

"Sand Blast Processes." By JOHN J. HOLTZAPFFEL.

"Modern Photogravure Methods." By HORACE WILMER.

AFTERNOON LECTURE.

THURSDAY, MARCH 14, AT HALF-PAST FOUR.—"Art Tuition." By PROF. HUBERT HERKOMER, R.A.

INDIAN SECTION.

Thursday Afternoons, at Half-past Four o'clock :—

JANUARY 31.—"India and its Women." By S. E. J. CLARKE, of Calcutta. (The paper will be read by SIR ALEXANDER WILSON.)

FEBRUARY 14.—"Village Communities in Southern India." By C. KRISHNA MENON, Lecturer on Agriculture at the Sydapet College, Madras. SIR CHARLES ARTHUR TURNER, K.C.I.E., will preside.

MARCH 28.—"Chitral and the States of the Hindu Kush." By CAPT. F. E. YOUNGHUSBAND, C.I.E.

APRIL 25.—"The Coming Railways of India, and their Prospects." By J. W. PARRY, A.M.Inst.C.E., late Executive Engineer Indian State Railways.

MAY 23.—"Punjab Irrigation: Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

The meetings of March 28, April 25, and May 23 will be held at the Society of Arts; those of January 31 and February 14 at the Imperial Institute.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday evenings at Eight o'clock:—

January 22.—"Russian Armenia and the Prospects for British Trade." By Dr. A. Markoff.

February 19.—"Paraguay." By A. F. Baillif, Consul in London for Paraguay.

March 5.—"Colonies and Treaties." By Sir Charles M. Kennedy, K.C.M.G., C.B.

April 2.—"Commercial Education in Belgium." By Professor William Layton.

April 30.—"Madagascar." By Captain S. Pasfield Oliver.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

February 5.—"Drawing for Process Reproduction." By Gleeson White. Lewis Foreman Day will preside.

February 26.—"Mediæval Embroidery." By Mrs. May Morris Sparling.

March 19.—"Carpet Designing." By Alexander Millar. J. Hungerford Pollen will preside.

April 23.—"Art of Casting Bronze and Copper in Japan." By William Gowland. Prof. W. C. Roberts-Austen, C.B., F.R.S., will preside.

May 7.—"Recent Improvements in Designing, Colouring, and Manufacture of British Silk." By Thomas Wardle.

May 28.—"The Decoration of St. Paul's." By Prof. W. B. Richmond, A.R.A.

Cantor Lectures.

Monday Evenings, at Eight o'clock :—

Professor Silvanus P. Thompson, D.Sc., F.R.S., "The Arc Light." Three Lectures.

January 21.—Lecture II.—Optics of the arc —Temperature of crater and of peak—Distribution of light and of invisible radiation.

January 28. — Lecture III.—Arc-lamp mechanism—The requirements to be met, and methods of fulfilling them—Alternate current lamps—Special lamps—Qualities of carbons—Accessories.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Silvanus P. Thompson, "The Arc Light." (Lecture II.)
Imperial Institute, South Kensington, S.W., 8½ p.m. Dr. J. Walter Gregory, "Experiences and Prospects of African Exploration."
Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. H. Blackbourn, "The London Building Act, 1894."
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Paper on "Australian Flora."
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Sir Robert Ball, "Comets."

Tuesday, Jan. 22 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Dr. A. Markoff, "Russian Armenia and the Prospects for British Trade."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The Internal Framework of Plants and Animals." (Lecture II.)
Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.m.
Photographic, 50, Great Russell-street, W.C., 8 p.m. Mr. Alfred Watkins, "Control over Results in Development."

Wednesday, Jan. 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. G. Stanton, "Tea."
Geological, Burlington-house, W., 8 p.m. 1. Mr. Alfred Harker, "Carrock Fell: a Study in the Variation of Igneous Rock-masses." Part II. "The Carrock Fell Granophyre." Part III. "The Grainsgill Greisen." 2. Mr. F. R. Cowper-Reed, "The Geology of the Country around Fishguard" (Pembrokeshire). 3. Mr. J. Logan Lobley, "The Mean Radial Variation of the Globe."
Photographic Club, Anderton's Hotel, Fleet-street, E.C. Mr. Birt Acres, "A Talk about Light."
Peoples' Palace Chemical Society, Mile-end-road, E., 8 p.m. Dr. T. E. Thorpe, "Some Causes and Conditions of Chemical Change."
Royal Society of Literature, 20, Hanover-square, W., 8 p.m.

Thursday, Jan 24...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Imperial Institute, South Kensington, S.W., 8 p.m. Mr. George Murray, "The Pastures of the Sea."
London Institution, Finsbury-circus, E.C., 5 p.m. Rev. Prof. Shuttleworth, "Utopias: Ancient and Modern."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. S. Lilly, "Four English Humorists of the Nineteenth Century." (Lecture II.)
Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. E. Kingsburn, "The Origin and Development of the Telephone Switch Board."
Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Eric S. Bruce, "Some Phenomena and Illusions of the Eye."

Friday, Jan. 25...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Sir Colin Scott-Moncrieff, "The Nile."
Clinical, 20, Hanover-square, W., 8½ p.m.
Physical Science Schools, South Kensington, S.W., 1. Prof. Ayrton and Mr. Medley, "Tests of Glow Lamps." 2. Prof. Anderson and Mr. McClelland, "The Temperature of Water at its Maximum Density."

Saturday, Jan. 26 ... Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. Lewis F. Day, "Stained Glass Windows and Painted Glass." (Lecture II.)

Journal of the Society of Arts.

No. 2,201. Vol. XLIII.

FRIDAY, JANUARY 25, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Professor Silvanus P. Thompson, D.Sc., F.R.S., delivered the second lecture of his course on "The Arc Light," on Monday evening, 21st inst.

The lectures will be printed in the *Journal* during the summer recess.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

INDIAN SECTION.

Thursday, January 17, 1895; Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., in the chair.

The paper read was—

THE LUSHAIS AND THE LAND THEY LIVE IN.

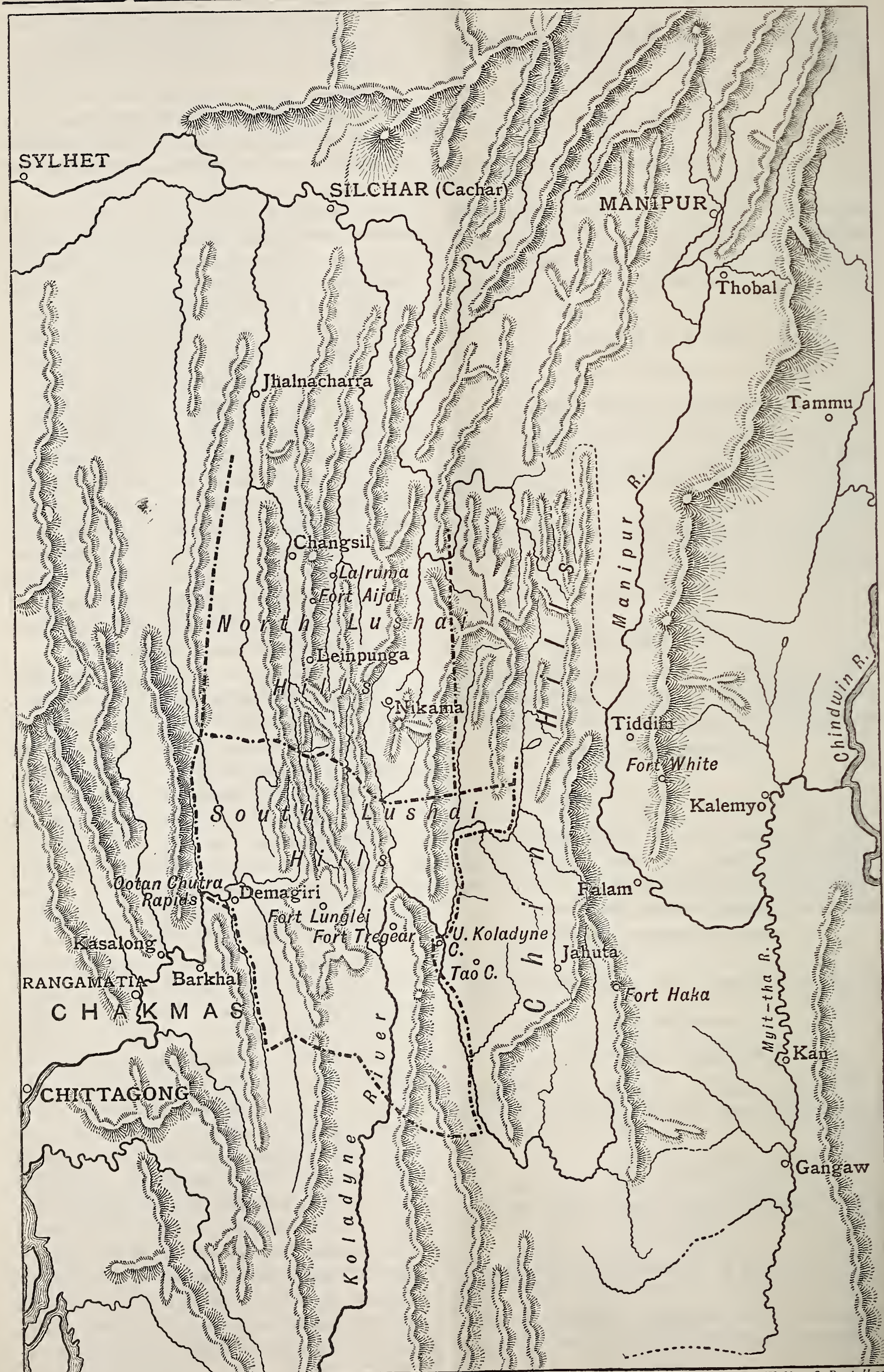
By Captain J. Shakespear, D.S.O.,
Leinster Regiment, Superintendent South Lushai Hills.

It must not be thought, because I have undertaken to write a paper on the Lushais, that I know all about them. Far from it; after six years among them I feel more diffidence about setting up as an authority on the Lushais than I did after the same number of months. All I can offer you is a description of the Lushais as I have found them myself, and as full an account of their manners and customs as my personal knowledge will admit of.

If in some particulars my Lushais are different from those described by other people, I hope you will remember the term includes many petty clans, each of which has some customs and beliefs peculiar to itself; so that a description which may be applicable to a tribe living on one side of a river may very well be quite incorrect regarding the tribe on the other bank. In fact, I should prefer you to consider this paper as a description of the South Lushai hills and their inhabitants only.

The tract of country now known as the Chin-Lushai hills lies to the east of the Bengal district of Chittagong and the native State of Tipperah; on the north it is bounded by the Sylhet and Cachar districts of the province of Assam; on the east by several districts of Burma, while to the south lies the Arracan district of that province.

It is, roughly, about 150 miles square, and is surrounded by British or protected territory. Until the annexation of Upper Burma the Government of India abstained, as far as possible, from penetrating into these hills, feeling that it was useless to subjugate the tribes on their borders, only to come in contact with more warlike and powerful tribes at every step. For this reason the many raids of the hill men passed almost unpunished. Occasionally a punitive column would be sent to avenge some unusually daring raid; the result in every case was the same. After overcoming great difficulties and suffering great hardships the force would arrive at the village of the offending chief, only to find it deserted and cleared of everything of any value; a few heaps of rice would be burned, a few cattle and goats killed, perhaps a few shots would be exchanged with an enemy who took care never to show himself, and the column would return in hot haste to escape the unhealthy weather which precedes the breaking of the rains. In every case our troops and followers suffered much from sickness, and the difficult nature of the country made operations so expensive that the Government were in no hurry to repeat the experiment. This reluctance to adequately punish the outrages committed by the hill tribes was, of course, mis-



MAP OF THE LUSHAI DISTRICT.

construed by these savages, who continued to raid British territory, quite oblivious of the fact that events which were happening in Upper Burma were likely to alter the behaviour of the hitherto complaisant white men. Upper Burma once annexed the days of independence for Lushais and Chins were numbered. In 1888, after a series of particularly audacious raids on the Chittagong and Burma borders had brought matters to a head, the work of conquest and pacification was commenced by columns pushing into the hills from all sides, and establishing permanent posts. In spite of several risings, progress has been made so rapidly that all the tribes in the Chin-Lushai hills now pay their tribute regularly, and the troops are being replaced by armed police. It is not too much to hope that there will be no more serious risings, and that the country will remain as quiet as it is at present.

The Chin-Lushai hills have been divided, for administrative purposes, into three main divisions:—1. The Chin hills, the eastern half of the tract, adjoining Burma, and governed, under the orders of the Chief Commissioner of that province, by a political officer with several assistants. 2. The North Lushai hills, comprising the hills lying to the south of Assam, the Chief Commissioner of which controls them through a political officer, whose headquarters are at Fort Aijal. 3. The South Lushai hills, which lie south of the Fort Aijal district, and east of the Chin hills. The headquarters of this tract are at Lungleh. The officer in charge is styled superintendent, and is under the Commissioner of Chittagong.

Before speaking of the people, I will try to describe the country in which they live. The western or Lushai portion consists entirely of narrow, precipitous ranges of hills, running mostly north and south, separated by deep, ravine-like valleys. The hills have an average elevation of about 3,000 feet, though there are peaks which reach 6,000. The eastern or Chin portion is less regular in its formation, the streams following most tortuous courses. The average elevation of this part is also much higher, and the hills are not so steep nor the valleys so narrow. Mr. De la Touche, of the Indian Geological Survey, who has examined the district, thinks that it once formed the bed of a mighty river which, in ages long gone by, flowed southward from the hills of Assam. The bed of this torrent has become crumpled up into steep ridges, either by the shrinkage of the earth's surface or by volcanic action. On some of the highest hill-tops one comes across huge boulders, some as much as 40 feet high, and smooth slabs of rock with water-worn holes, such as one sees in the beds of mountain torrents. The upheaval of the surface seems to have left several large lakes, which in time broke through their banks, and left beautiful open upland valleys, which form a most pleasant variety to the steep hills smothered in jungle. The one I know best is the Van-lai-phai, or "Earth clear to the sky," which lies a few miles north of Fort Tregear. It is roughly six miles long, and varies at the bottom from a quarter to half a mile, but the slopes are gentle and undulating, which gives one the feeling of being in an open country, very pleasant after several days in the jungle. A stream flows down the middle of the valley, and evergreen oaks are dotted about in small groves, and line the banks of the many streamlets which flow in from the small valleys on either hand. To the north are open downs, while to the south the valley narrows into a gorge through which the stream escapes over a ledge of rock, leaping several hundred feet into the valley below. The hills are composed of sandstone and shale, chiefly the former, covered by a very thin layer of earth. Useful minerals there are none, nor is there any lime to be found. Fossils of an estuarine character have been found in very small numbers. Salt springs are comparatively common, but I have only heard of one of which the people found it worth while to make use. The western half of the country is covered with dense jungle, while the eastern, where the rainfall is less, is fairly open, firs, oaks, and rhododendrons being the chief trees.

From the summit of the Lungleh-hill a grand view of the country is obtained. Turn to the west, and you look down over 2,000 feet on to a confused mass of hills and valleys stretching away to the horizon. It is a wonderful sight, these miles upon miles of tree tops. Look which way you will, little but forest is to be seen; here and there a cliff shows out white amidst the green, patches of bright yellow show where crops of rice are ripening, and here and there a hill-top is crowned by a little brown patch, denoting a village. For some twenty miles westward of Lungleh the country is practically uninhabited, and is the great hunting ground of the Lushais. In former times, when a cordon of police posts was maintained round the hills, our subjects drew back to escape from the raids of the Lushais, while they, on their part, drew back

o put a greater distance between their villages and our punitive columns. Thus a belt of uninhabited country was created all along the old frontier. Now that all fear of raiding has ceased, and the Lushais have become accustomed to our presence, this belt of deserted forest is quickly being populated both by the people of the Chittagong hill tracts and by the Lushais, as the land having been so long uncultivated, yields unusually fine crops. It would, I imagine, be difficult to find jungle more dense than that in the valleys between Demagri and Lungleh. Huge trees, with great buttressed trunks, raise their straight white stems to the leafy roof; creepers of all sizes wind round these massive columns, hanging in festoons from one to the other, or trail along the ground, twisted and knotted together. Ferns grow in profusion on all sides, on the rocks beside the streams, clinging to the trunks of the forest kings, and swinging in mid-air on the giant creepers. The branches of the trees are so covered with orchids that the bark is barely visible, while beneath is a tangled mass of vegetation, thorny canes and shrubs being twined together in such confusion that it is only by dint of much cutting and clearing that a passage can be made through it. The pace at which this jungle grows, during the rains, is almost incredible. In spite of two clearings yearly, the Government road is at times almost impassable. The bamboo jungle is monotonous to travel through, as the bamboos do not grow in clusters, but each stem by itself, and among the straight green stems there is no undergrowth to relieve the eye. Birds and animals, too, do not frequent such jungle; in fact, even in the tree jungle, animal life appears to the passer-by strangely rare, but if one remains still one may see golden orecles and other brilliantly-plumaged birds, flit through the shade; or a couple of tree martins glide noiselessly from tree to tree; or a dark brown squirrel may come and peer at the intruder from behind a bough, clucking angrily when discovered. The discordant yells of the hoolook, or gibbon monkeys, are often heard, but the animals are seldom to be seen. In parts unfrequented by men game is, of course, more common, and elephants, gyal or bison, double-horned rhinoceroses, pigs, tigers, sambhur, and bears are to be found, but the density of the jungle prevents much sport. The rainfall at Lungleh has varied between 130 and 160 inches a year since we occupied the place in 1889. Owing to the steepness of the hillsides and the narrowness of the valleys, the rivers rise with wonderful rapidity; in the last four days of May, 1889, over 27 inches of rain fell, which caused the Kurnaphuli river to rise over 50 feet, and occasioned an enormous number of landslips. The rains generally break about the last week of May, and from then till the middle of October it rains more or less continuously. There are sometimes a few days rain near Christmas, and March, April, and May are hot, unsettled months, during which violent storms come rolling over the hills from the north-west; they do not last long, but do a great deal of damage to our houses and telegraph lines. During the summer of 1892 the roof of my house was twice blown off, and some other buildings were completely overturned.

The Lushai hills had a very bad reputation for unhealthiness, and there can be no doubt that the climate is not good, but it has not turned out to be as bad as we expected. The low valleys, from March to November, are certainly very unhealthy, but the hilltops—on which are our main posts—are no worse, as regards climate, than many stations in Eastern Bengal or Assam. The chief complaint is fever, from which the Lushais suffer greatly, in spite of the villages being always placed on the highest sites available, as they have to spend much of the rainy season among their crops, which are generally at a lower level. Eye complaints are also very common among the people, which is not surprising when one considers the smoky atmosphere of their houses, and the small regard they pay to personal cleanliness. The infant mortality is high, and this, too, is only natural, for as soon as a child can walk it is allowed to run in and out of the house, without any more efficient protection from the weather than a necklace or an earring, besides being introduced to the delights of alcohol and tobacco during the first year of its existence. A father once said to me, on my asking of what his son had died, "Oh, nothing in particular; he was an infant; they often die!"

There can be no doubt that all the tribes inhabiting the mass of hills lying between Bengal and Burma are of the same race. Their ancestors probably formed part of the great horde of Turanians, who, coming from the north, scattered themselves all along the N.E. frontier of Bengal. The differences which we now notice between the various tribes can, in many cases, be traced to the effect of their surroundings. The Lushai is a

semi-nomad, and we may attribute this to the facility with which he builds his house of the all-prevailing bamboo, and is, therefore, ready to move his abode when he has exhausted the land in his immediate neighbourhood. This happens every four to seven years, as the Lushai never cultivates a piece of land twice. The Chins, on the other hand, having but few bamboos in their country, are obliged to build more substantial houses out of planks, hewn, with much labour, out of pine trees. A good house will take two to three years to build. The natural result of this is that the villages are permanent, and that, as a rule, a man does not shift his domicile. As the Lushais have to carry all their worldly goods from the old to the new village every few years, they have no incentive to accumulate ornamental articles or luxuries. They have thus become people of few wants, careless of the future and quite content with their present surroundings. In a word, they are lazy, happy-go-lucky folk, casual and unsettled in all their habits. The Chins, on the other hand, have most of the characteristics of a settled race. Their institutions are on a firmer basis, and they themselves are more civilised and prosperous. As to physique, they are finer than the Lushais, which is probably due to their living in a healthier and more open country.

The languages of all the tribes have, undoubtedly, sprung from the same root, but show signs of different foreign influences, as if their forefathers absorbed words and expressions used by the various clans whom they dispossessed. The language is monosyllabic, and unwritten. The vocabulary is larger than the present savage condition of the people would lead one to expect. It is very euphonic, many sounds being introduced, much at the pleasure of the speaker, with no other object.

After the forefathers of the Chins and Lushais had ejected or absorbed the former inhabitants, they did not sit down and dwell together in unity—far from it. The history of the Lushais, if it could be written, would be a series of battle stories. A record of continual fighting between petty chiefs for the possession of some particularly advantageous village site, and of wars on a larger scale between sets of kinglets for certain tracts of country, the members of each combination being connected by ties of blood or common interest; or a number of small chiefs acting in concord with a more powerful neighbour, from fear rather than from affection. Many an evening have I spent listening to the tales of the good old times, when might was right, before the soldiers of the "Company's Mother" (as the Lushais call the Queen, the fame of John Company surviving to this day in these far off parts), came and enforced *Pax Britannica.* The people whom we call Chins are known to the Lushais as Poi, and between them there has long been a feud, and tradition tells of a great war, in which the Lushais were badly beaten, and forced to evacuate the country to the east of the Tyao river. Mr. Macnabb, who was Political Officer at Haka, found traces of earthworks, which he was told had been made by the Lushais when making their final stand against the Pois. This struggle was followed by another sanguinary war some 12 years ago. The Lushais were again defeated, mainly in consequence of an injudicious attempt to carry the war too far into the enemy's country, which ended in their losing 40 men in an ambush. A *sauve qui peut* followed, the Pois assembling along their line of retreat, and, as an old man told me, the Lushais never stopped running till they reached their homes in ones and twos, having had to abandon the paths and find their way through the jungle. The Lushais still speak sadly of their heavy loss, and often regret that, owing to our presence, the chance of avenging it has passed away for ever. Besides the raiding of several villages, continual slaying of small parties and isolated individuals engaged in cultivation occurred during this war, which in this respect differed from the other great war known as "The War of the North and South." The combatants in this war, which took place some 40 years ago, were Lushais only; in fact, it was a regular civil war, the chiefs on both sides being of the same family. The villages of the combatants were so close together that their cultivated lands, in many cases, absolutely touched each other, and so had the war been conducted on the same principles as the Poi war the combatants must have starved, for no cultivation could have been carried on at all, and neither party could obtain any grain in any other way. Both sides, therefore, prudently agreed to abstain from ambushing each other while engaged in cultivation, and the war was carried on by attacks on each others villages only. The Lushais' one idea in warfare is to incur as little danger as possible. If a village is to be attacked the greatest secrecy is observed, and if, after a tedious journey of several days, the people of the threatened village are found to be on the look-out, the

whole band of would-be raiders will, as likely as not, quietly turn round and go home; the fact that their enemies were on the alert being considered quite sufficient to exempt them from any charge of cowardice. Their ambushes also are generally arranged more with the idea of enabling them to beat a hasty retreat, unobserved, than of making certain of killing the enemy. It is fortunate for us that this is so, as in so densely-wooded a country an enemy who did not mind freely risking his skin would be extremely formidable.

Once, when exploring, I was dining in a house in Jaduna's village, when suddenly the door opened, and a voice out of the darkness said, "Ka tlengta" (I have arrived). I looked up and saw framed in the doorway a Poi in full war-paint. His only garment was a dark blue cloth, wound tightly round his waist, with an end hanging down in front. Over the left shoulder hung a well-filled havresack covered with the skin of a tiger's head; over the other shoulder hung a short dah, in a gorgeously-painted scabbard, and a highly-ornamented powder-horn; in his hand he carried a gun ready loaded. He stood for a few moments dazzled by the bright light and then fled. I was the first European he had ever seen. I went out and found the village crowded with warriors equipped like my visitor, but some, in place of the gun, had spears and shields. They were a raiding party from the north on their way to attack a village near Fort Tregear. Each man carried some joints of bamboos, pared down till they are but little thicker than stout paper. Some of these contained boiled rice rammed solidly down, the others were filled with water, which was prevented from escaping by a plug of leaves. Thus equipped, they were ready to go for several days and nights with only a few hours of rest. Their tactics are to crawl up to a village during the night, and just at dawn fire one volley and then rush in among the frightened inhabitants, who, taken by surprise, seldom make any stand. No quarter is given to the men and old women, but the young women and children are carried off as slaves. The village having been looted, is set on fire, and the raiders set out at once for their home, generally travelling without a halt till they think themselves safe from pursuit. Woe betide the captive who cannot keep up — a thrust of a spear soon ends her journey. On reaching their village, the victors are greeted with shouts and entertained with unlimited beer, and those that have brought back heads, even if they be only those of old women, are treated as heroes. The Chins or Pois are a far braver race than the Lushais, who explain this by the following legend:—Tlandro-pa, a mythical hero, gave a great feast, to which all men and animals were invited. To his guests he gave presents, to the Poi a sword, to the Lushai only a cloth.

Although the Lushai is not a brave man, according to our ideas, yet I have seen him do some plucky things. Once while I was posting sentries, after having forcibly occupied a village, I saw two Lushais, apparently unarmed, approaching from the direction of a friendly village; as I was expecting some men from there with my letters, I let them come on, which they did without any hesitation, till within 100 yards of us, and then were momentarily lost to view behind a small bush. Two bullets whistled past our heads, and the Lushais dashed away and, in a second, were out of sight, narrowly escaping several bullets. On many occasions they have held stockades till our men were within a few yards of them; but I know of no case of their having allowed our troops to come to close quarters.

The term Lushai is properly only applicable to a small number of those to whom we generally apply it; for, besides the main division of the people into Lushais and Pois, or Chins, there are many smaller divisions, which are called after the names of their founders. Some are included in the Lushai clan; others are not, although their language and customs are, in many cases, identical. I believe that these families which are not included in the term Lushai, are the descendants of chiefs who at one time had independent villages, of which they were deprived by Lushais, who, I imagine, obtained their present country by conquest. The Lushai families are named after the prominent men among these successful invaders. The chiefs are all of one family, called indifferently Thangur or Syloo—at least, all claim to belong to this family—but the powerful chiefs of the northern hills will not, I believe, admit the relationship of the less powerful chiefs, who live farther south.

Besides the Syloos, who rule among the Lushais, there are other—so-called—royal lines: for instance, the Jadeng and Fanai. The former is an example of a decayed aristocracy, for, within the memory of living men, the Jadeng chiefs ruled over a large tract of country round Champhai, but they fell out with the Syloos, and were worsted in a long war, losing their country; now, only two or

three small hamlets remain under chiefs of this family. The Fanai, on the contrary, are an example of a rising race. Their ancestor was a certain Roreyluova, who appears to have been a restless, ambitious fellow, with plenty of pluck and worldly wisdom. He gained the friendship of several chiefs of the powerful Jahow tribe (a Chin tribe, living east of the Tyao), by assisting them in their various wars, in which he made such a name for himself, that, to retain his allegiance, they allowed him to establish a small village on the Lushai border of their territory. His village quickly grew, and he eventually cast off the yoke of the Jahows, and, with the help of some Lushai chiefs, maintained his independence. His largest village was on a hill called Mollienpui, and hence the whole clan is sometimes called Mollienpui. Roreyluova had nine grand and great grandsons living, who are all chiefs. When we first occupied the country I found that the Fanai were much feared by the tribes to the south of them, and that even the far more numerous Syloos were chary of interfering with them. The whole of the country which they now hold has been won by the sword, and I have no doubt that, but for our arrival on the scene, the Fanai would have fought their way into the front rank of local dynasties.

The most interesting among the minor clans to be found in a Lushai village is that of the Ralté. These people are found most frequently in northern villages; their language differs in a marked manner from that of the Lushais, especially as regards grammar. As a rule they live in a distinct part of the village and do not intermingle with the Lushais. Mr. McCabe says that they are reported to have come from the north, and to have been conquered by the Lushais, who consequently look down on them; he further states that the honour of providing victims for any human sacrifices belongs to this family. I must say that I have not, personally, heard of the Lushais practising this rite. It seems probably that originally the Ralté were forcibly brought from their homes, and made to live as slaves in the villages of their conquerors. In Kairuma's village there are now some 80 families of the Hmar clan, who were thus dragged from their homes on the Manipur border by his father Vuta. They are not allowed to leave the village, and should the chief require an animal with which to feast a friend, he levies it from the Hmar; they also have to pay various fees in kind to the chief whenever a marriage or birth occurs in their families. The tribe from whom those unfortunates were torn have not given up the struggle, and periodically send parties to waylay Kairuma's folk, hoping by thus continually worrying them to obtain the release of their friends.

A Lushai village is always built on the top of a hill, and in this respect differs from those eastern tribes who generally choose the side of a hill, so that they can bring the water of some spring in a series of channels right into the village past every door. In fact, as Major Walker has observed, the Lushais seem to build their village and then look for the water, while the Chins first find the water and then build the village. This is one of the many results of the nomadic habits of the Lushais, and is also partly due to the fact that the hills in the Lushai country are lower, and, therefore, it is necessary to go as high as possible to obtain a healthy situation, whereas the more fortunate Chin lives where the average height of the valleys is nearly that of the Lushai hill-tops. The idea of securing a good defensive position has also its weight with the lazy Lushai, who would never take the trouble to make the elaborate defences with which the Chins surround their villages.

Outside the village there are generally several platforms of some rough logs, with some upright posts behind them, adorned with the skulls of animals, gourds, rags, and even old bottles, tins, and pots. These platforms are in memory of departed heroes, and are used as seats on which, towards evening, groups of gossipers assemble to discuss the latest news.

Nowadays, hardly any villages keep up even a semblance of defences, for since our occupation the days of settling disputes with gun and spear are over. But when we first visited them every village was defended, on the accessible sides by a timber or bamboo stockade, outside of which, to a distance of some feet, the ground was thickly studded with bamboo spikes, beyond which, again, was a light bamboo fence. If an attack was feared, the approaches to the village would be protected for two or three miles with bamboo spikes to such an extent that, for months afterwards, the road was dangerous. Mr. Pughe, of the Bengal Police, was wounded thus so severely that he has never entirely regained the use of his leg, the spike having injured his kneejoint.

The gates were generally placed at the top of a steep incline, and defended by a timber guard-house, flanking the entrance. The gate

itself was either composed of two large slabs of timber, or of a number of stout saplings suspended, by holes cut through them at one end, to a cross-bar; during the day these were pushed to one side, but at night they hung down in the gateway, and were secured there by cross-bar. In addition to these defences, there was generally a guard-house at some distance from the village, situated either where the road was very narrow and steep, or at some corner, so that it was not visible till the stranger was close upon it; these houses were only occupied when there was reason to fear an attack. Passing through the gate, one finds oneself in a sort of irregular street leading up to the highest point of the village, where there is generally an open space, from which other streets branch off. On one side of this space will be the chief's house, and on the other the "zalbuk," or guest-house. The chief's house can only be distinguished from those of his subjects by its superior size. They are all built of the same materials, and vary very little in construction. The framework of the house is of timber, cut close at hand, and roughly dressed with an axe; the walls are of bamboo matting, fastened to the frame posts with strands of cane—in fact, all the materials of which the house is made are tied together with this useful plant, which can generally be found close at hand. The floor is always raised, partly to avoid the trouble of levelling the ground, but chiefly for the sake of dryness; it is composed of bamboos laid close together, and covered with matting of the same material. The house is thatched with cane or palm leaves, kept down by broad bands of bamboo, which, reaching from eave to eave, give the roof a rounded appearance. In front of the house is a platform of rough logs, access to which is gained by climbing up two or three sloping poles. The roof of the house projects over this platform, forming a verandah, in which the daily supply of rice is cleaned by the females of the household; one or two sections of tree trunks are let through the floor, their lower ends resting on the ground, in these the paddy is pounded with long wooden pestles, until the husks are sufficiently loosened to be removed by winnowing. Facing you, on the left, is a small door, which admits you to the house. Most houses have only one room, but chiefs and wealthy folk are better housed, and have two; the first being the abode of the slaves and followers, the inner one the chief's own chamber. To the right, against the wall, is a hearth of earth, on which all the meals are cooked, over this, to keep the sparks from setting fire to the roof, are two shelves, on which things which require drying and smoking are kept. On either side of the hearth is a bamboo bedstead for the family. Beyond this room there is generally a small compartment, a sort of lumber-room. A small door at the end opens into a little verandah, which is the chief's private sanctum, the whole of the rest of the house being more or less public, for the Lushais have democratic ways, and treat their chiefs with scant ceremony, according to our ideas. Furniture is scarce in a Lushai house, a few baskets, with conical lids, to hold the family wardrobe and other treasures, some cooking pots, one or two large jars to brew rice beer in, a few gourds filled with pigs' fat or seeds, and a miscellaneous collection of articles, such as rat-traps, snares, baskets, and a loom or two complete the possessions of an ordinary family.

Among the Lushais each village is an independent unit, governed by its chief, and it is not customary, as it is among the Chins, for one chief to pay tribute to another. A chief, as a rule, must belong to the royal family, but he must also show himself a fit man to govern, or he will soon find himself a chief without any subjects, for, owing to the ease with which a Lushai can build a new house, he thinks nothing of moving should his chief be tyrannical, or foolish enough to select a bad site for the village. I remember a case in which, owing to a bad harvest, and the inexperience of the chief, a village dwindled from 800 to under 200 houses in one year.

This facility of removal is really the only check on the abuse of the chief's power, but it is a very effective one, as the ambition of every chief is to have as large a village as possible, and he, therefore, abstains from any acts of tyranny which would seriously endanger his popularity. Of course, in cases where a chief is one of a family of powerful brothers, or other near relations, this check is not so effective, as, should a man leave a village against the chief's will he would persuade his relatives to refuse the fugitive admission to their villages. Naturally, the power of the chiefs varies greatly, being largely dependent on the personal character of the ruler. Theoretically, a chief is a despot, whose order no one can dispute; practically, I have found them very benevolent despots, and in most cases hardly despots at all. The

chief is looked upon as the head of the community, who has to choose the site for the village, direct when it shall be moved, where and when the people shall cultivate, regulate all matters between the village and any other community, and, in case of famine, make arrangements for obtaining food for his people; his house is the "poor house" of the village, into which any destitute person can go; but once admitted as a member of the chief's household a person cannot leave it without the chief's permission, which generally has to be purchased.

Such a person becomes, in fact, a slave, and gives his labour in return for his keep; as he has to work no harder for the chief than he would for himself, and as, while in the chief's house, he has no anxiety as to his food, and is also a person of some consequence, the bargain is a fair one. When children are left unprovided for, they are placed in the chief's house, as a matter of course. This custom of domestic slavery seems admirably suited to the people, and to the peculiar circumstances under which they live.

It is not only the chiefs who are privileged to own slaves; any one who is rich enough can do so. A slave who does not like his master may, without consulting the master, transfer his services to any member of his master's family. This is based on the custom of considering property, to a great extent, as the possession of the family and not of the individual. It is evident that, not very long ago, this was the general rule, but it is dying out, and is now only enforced when any one who has stolen anything can not be easily reached, restitution is then demanded of the nearest member of his family.

In return for all the chief does for his people, they have to give him a share of the harvest, the amount depending on the nature of the site which has been allotted to each. The chief also receives a hind leg of every beast killed in the chase: in his capacity as judge, he takes a portion of any fine inflicted, even though the offence in no way concerns him. If his slaves are not sufficiently numerous to do the chief's cultivation, the villagers have to assist, and they also have to build the chief's house. As far as I have been able to gather, the present system is admirably suited to the conditions under which the people live, and few of them would like to see any change. The chiefs, as a rule, really try to do their best for their people, who, on the other hand, feel considerable affection for them. I fear that it is unavoidable that the power of the chiefs should decline under our rule, and that a time will come when we shall be obliged to interfere in the internal affairs of the village communities, but the time is a long way off yet. We have, of course, had to deprive the chiefs of the right to inflict capital punishment, but any further interference between them and their people would, I consider, be most unwise. Every chief has at least one adviser, and most of them have two or three. On the Chittagong side we call them Carbaries, while on the Assam border they are termed Muntris; the Lushais themselves call them Kawnbal or Upa, which latter means only old man. These men are selected by the chief for their wisdom and power of managing the villagers, and, nowadays, for their skill in framing excuses which will appeal to the heart of the exacting Political Officer. They have no particular privileges, and their influence is purely personal. As a rule, when a young chief is started with a village of his own, his father sends one of his wisest men to guide him. Besides the carbaries, there are generally one or two men with a taste for wandering and trading, who have picked up the dialect of the neighbouring tribes, and perhaps a little Bengali. These act as ambassadors.

The "zalbuk," of which I have already spoken, is an important institution. It takes the place of our club, and also of the "dak bungalow," or rest-house. It is a large barn-like building, approached at one end by a rough slope of logs. The outer wall comes down to within 3 feet of the top of this slope. Stooping under this wall, you find yourself confronted by a bamboo barrier about 2½ feet high, topped by a large log, worn smooth by the friction of many Lushais sliding over it into the zalbuk. In the centre is a large earthen hearth, a few inches lower than the rest of the floor, on which a fire is always smouldering. At the far end is often a raised daïs, behind which is an opening in the wall, whence the young bloods can watch the passers by, much as the club *habitués* do here in London. Of an evening a huge fire is lighted on the central hearth, and all the bachelors, and such Benedicts as are not kept at home by their wives, gather round and sing songs, tell tales, and make merry, smoking hard the while. The young unmarried men all sleep in the zalbuk, which is also at the disposal of all strangers. In a large village there will often be several of these structures,

which are built by the united labour of the whole village, under the orders of the chief.

In front of some of the houses you will notice forked posts 10 or 12 feet high, and roughly shaped; each one was adorned with the skull of a gyal, or tame bison; which the owner of the house has killed and shared with his neighbours. Those who have thus feasted the village are privileged to wear a cloth of a particular pattern. Round many of the houses are small enclosures, in which plantains, sugar-canes, beans, &c., are grown. The Lushai thinks flowers not worth the trouble of cultivating.

Should any person of importance have died recently, his tomb will form a prominent object in the village. The most elaborate tomb which I have ever seen was that of Sangliena, a Syloo chief. There was a rough circle of posts, on which were displayed the heads of the animals which had been killed in his honour. In old days the heads of men would probably have decorated some of these posts. The desire to get sufficient heads to do honour to a powerful chief's memory was one of the commonest causes of raids. The circle of posts was broken on one side by three large stones, placed upright, the largest being 10 feet high, and carved with figures representing the deceased chief, with his wife and son, and the men and beasts he had killed during his lifetime. Near the top of the largest stone was a hole, with an old gun barrel thrust through it, from which hung two gongs, trophies of a successful raid carried out some years before our occupation.

The funeral of a Lushai chief is a lengthy operation. Directly the breath is out of his body his followers testify their grief by dismal howls, the firing off of guns, beating of gongs, and otherwise making a noise. Then the serious preparations commence; all the pots in the village are collected, and beer-making on the largest possible scale begins. Messengers are sent off to call in all the relations of the deceased, and any neighbouring chiefs who have been his friends. As soon as the liquor is ready, drinking begins in earnest, and is kept up vigorously for two or three months. During all this time the corpse is kept hermetically sealed in the hollowed-out trunk of a tree, close to a large fire. For ventilation a bamboo tube is passed through the bottom of the box, and then buried in the ground. By the time the period of mourning is over, little remains of the body but dry bones; some of these are kept as heirlooms, the rest being buried in front of the house. An ordinary individual is not honoured with so lengthy a funeral, being generally buried in front of his door within twenty-four hours of his death; the libations, however, are not omitted. The Ralté, of whom I have spoken, bury their dead outside the village. The Pois have different customs; they do not enclose the bodies, even of chiefs, in hollowed trees, but dry them over a fire, and after a month or two of drinking and mourning they bury them wrapt up in the best clothes they have. The grave is about 5 feet deep, and consists of a shaft with a tunnel leading out of it, in which the body is placed, amply supplied with food, drink, tobacco, and sometimes weapons. From the tomb of the chief Howsata, we recovered the gun which he took when he surprised and killed Lieutenant Stewart and his survey party. Mr. Sneyd Hutchinson, Assistant Commandant of the Lungleh police, once attended a Fanai funeral feast. The corpse, dressed up in all sorts of finery, was placed at the end of the room, and the mourners sat along each side. Cups of rice beer were kept constantly circulating, and were always offered to the corpse in its turn.

The Lushais regard death very philosophically. Last winter, Lalruma, a chief living close to Lungleh, lost a son, and I sent a goat to be killed in his honour; a few months later Lalruma himself died, and as he had been a faithful and staunch adherent of ours I went to the village and drank much beer with the widowed queen, and had a gyal killed in memory of the departed. When I was leaving the widow said she had been almost reconciled to the loss of her son and husband by the honour I had done her. I assured her that when her turn came I would kill more animals and drink more beer, and she seemed quite happy at the prospect.

The Lushais dress very simply, and their fashions never alter; this is no doubt due to the fact that each lady has to make all the clothes for her whole family, from the raw cotton which she has first to assist in cultivating. The men wear a single cloth about 7 feet long and 5 feet wide, which is wrapped round the body, leaving the right arm bare. The women wear a short dark blue petticoat, kept up by a brass girdle, and reaching nearly to the knee, and a short white cotton jacket. In the winter they also wrap themselves up in cloths like the men, who then wear coats of white cotton, ornamented with lines of various colours. The men tie their hair in a knot behind the head,

and fasten it there with ivory combs and several sorts of pins made of brass, ivory, iron, &c. The men among the Pois wear their hair in a knot over the forehead, with a white turban bound round it, standing up high. The Fanai also tie the hair over the forehead, leaving the back hair hanging loose. The women, as a rule, merely twist it up into a knot behind. Among the Hmar, whom I have mentioned, the women plait the hair and coil it round the head.

The Lushai women affect huge ivory ear-rings. When young a hole is bored in the lobe of the ear, and a plug of wood or clay is inserted; this plug is continually changed for a larger one, till the hole is about two inches in diameter. With an ivory ring of this size, and half an inch thick in her ear, a Lushai maiden considers herself irresistible. Some of the men also wear earrings, but of more modest proportions, seldom more than a quarter of an inch across.

As a rule, the men are more careful of their personal appearance than the women, who have hardly time to attend to such vanities. The young men who are just thinking of marrying take great pains over their toilets, dressing their hair with plentiful supplies of pigs' grease, but after marriage they become careless. Both men and women wear necklaces of beads and amber; the latter are valued at absurdly high prices. The amber is much darker than that generally seen in Europe, being about the colour of October ale. It is hard to say where this amber comes from, as the Lushais tell you that it comes from Burma, while the tribes on the border say it comes from the Lushai side. Some of it is no doubt obtained locally. I have heard of it being found near Wuntu, on the right bank of the Kolodyne, but the bulk of it must have been imported. A fine necklace is valued at five or six hundred rupees, and the owner will tell you with pride of all its former possessors for several generations back. Cornelians are worn as earrings by the men, and are valued as high as Rs. 400 for a large stone.

During the rains men and women alike wear hats made of bamboo or cane, lined with leaves, so as to be quite waterproof. In very heavy rain they wear a curious form of head-gear, which somewhat resemble a large shallow basket, shaped like an oyster shell inverted, reaching from the forehead to below the waist, thereby completely covering the back. The Chins use a peculiar waterproof made of plaited grass. The Lushais do not mind their bodies getting wet, but they strongly object to their heads being moistened; even when bathing a man never wets his head. Every man carries a havresack, in which to stow such indispensables as tobacco, pipe, flint, steel, and a knife, and when on a journey, a meal of rice wrapped up in plantain leaves. Some tribes use guards of tiger, goat, and bear skin to protect the havresack.

Among the Lushais every person — man, woman, and child—smokes. I have seen a mother take her pipe out of her mouth and thrust it into that of her baby of a few months old. The men and women smoke pipes of different patterns, the women's being a diminutive adaptation of the hookah. The nicotine which collects in the water vessels of the women's pipes is carefully kept, and every man carries a small gourd full of this horrible mixture. When two friends meet, one offers the other a sip of nicotine, just as a short time ago one Englishman would offer another a pinch of snuff. The stuff is kept in the mouth a few minutes, and then ejected; it is said to be a stimulant. I only know of two Europeans who tried it; one said it was not as bad as one of his old pipes, but the other swallowed some under the impression that it was a choice brand of rice spirit, and was ill for several days. The tobacco is grown in the valleys near to water; it is home dried and has a very pungent smell.

The Lushais are the best-natured race I have ever met. Even if the cause of one's visit is an unpleasant one, such as to collect a fine, one has only to make a joke, and at once every face is wreathed in smiles. They have no idea of ceremony, and crowd round any visitor, sometimes carrying their investigations further than is pleasant, and receiving a kick or a blow for their pains; but this only makes the crowd laugh, and the sufferer most of all. This cheerfulness makes them very pleasant people to deal with, but their dilatoriness, their casual habits, and utter disregard of the value of time, often try one's temper greatly.

It is generally maintained that the Lushais are a very treacherous race, but I have not found them so. They certainly are not above employing a stratagem to get an enemy into their power, but, on the other hand, I found them very loyal and faithful to their promises. In 1892, Lalluova and his two brothers stood by me when all the neighbouring chiefs—their near relatives—were attacking me, and when they had every incentive to behave treacherously, for had they turned on me, it is certain

that they must have succeeded at first, and all their relations were trying to persuade them to do so, and threatening to attack them if they did not. Their own young bloods were chafing at having to carry our loads instead of shooting at us, and, to make matters worse, for nearly two months, while Captain Rose's column was finding its way through the unknown hills from Burma, I was unable to take the offensive against my many foes. Instead of listening to such proposals, Laluova used, on the approach of a convoy, to send scouts to scour the jungle on both sides of the road. Once these scouts came on a large party of the enemy in ambush, who inquired what they were doing there, and threatened to detain them till the party for whom they were waiting had passed. "Oh! the Sahib is not coming to-day;" they said, "he came to our village and there he got a letter from the Lungleh Sahib and turned back again. We are going to the next village to tell the Chief that the Sahib would not want coolies." So the ambuscade was broken up, and half an hour afterwards Mr. Daly, with a small escort of police, passed safely. Another time, two of Lalluova's men, while carrying my letters, were caught by a party of the enemy, who wanted to destroy the mail-bag; but the carriers, who were wise and cunning, used their tongues so well, that they finally persuaded their captors to let them go, and not to injure the letters, which they said were probably only from my mother.

During this time I was collecting a large quantity of tribute rice in Lalluova's village, and when the time for our columns to retire came, a considerable quantity of this rice was left, and in the hurry of departure I forgot to give any orders about it. The next year Lalluova faithfully handed over all this rice, without my having asked for it.

The parents are very fond of their children, and will often live for weeks on jungle roots, so as to give their little ones all the rice. The children seem to have a splendid time; they play all day, and no one interferes with them, except when some busy mother shouts to one of them to go and fetch some water or some wood. The men are great hunters, and spare no device to circumvent the denizens of forest and river. Dams are built across the streams, which force the water to rush down long bamboo shoots, carrying the fish with it into bamboo boxes, out of which they cannot escape. Snares and traps are set to catch every sort of bird and beast. Fences are made for miles through the forest, with openings at intervals; should an unwary animal or bird try to pass through one of these, it is either squashed beneath a log, or swung high in the air by a noose tied to the end of a suddenly liberated sapling. Once or twice a year large parties go off into uninhabited parts, living almost entirely on the flesh of the birds and beasts thus snared while they search for elephants. If a herd is found, all those who have guns creep up as near as possible and fire a volley into one of the great beasts, and if it does not drop at once, they follow it day and night until it does. The gibbon, or hooluk monkey, and the rhinoceros appear to be the only animals exempt from slaughter among the Lushais, the former because of a legend that at the "Thimzjing"—which I shall allude to later—a man and his wife were turned into gibbons. The Fanai do not kill the tiger, because they say that an ancestor of theirs, who was escaping from a distant village, to which he had been taken captive, was shown the way to his home by one of these animals.

The Lushais are eminently agriculturists; they keep a few goats and gyal, pigs, and fowls, but are in no way dependent on them. The chief crop is rice, which a Lushai considers as his food, *par excellence*, everything else, meat, vegetables, &c., are only luxuries. When there is a great feast of flesh it is cooked by itself in huge earthen pots, and then thrown out on to mats or plantain leaves, and the feasters gather round and eat it without any condiments, washing it down with the water in which the meat has been boiled. Immediately afterwards they adjourn to their own houses and consume their ordinary allowance of rice. They are not particular feeders, eating almost everything and not caring whether the meat is fresh or not. Dog is one of their luxuries, especially a puppy.

In February the Lushais begin to select the sites for their cultivation. These are called "Jooms." The chief has first choice, and after him the carbaries, and then the rest of the people, the tribute to be paid to the chief being regulated according to the quality of the ground each person receives. Having chosen the site for his joom, the Lushai has to clear it, a work of great labour, as the only tools available are his dao, a chisel-edged knife about 15 inches long, and a small axe with a head weighing about 1½ pounds. The thicker the jungle the better crop is a Lushai maxim. In tree jungle all the undergrowth and as many of the trees as possible are felled; those that are too big for felling are cleared of

their branches. In parts where the jungle is bamboo the work is comparatively light, but the crop is not generally so good; on the other hand bamboo land can be cultivated every four or five years without the bamboos being exterminated, so that if a chief has two village sites some miles apart he can move backwards and forwards from one to the other all his lifetime. Tree jungle, if continually felled and bunned, gives place to coarse grass, and the land, according to Lushai ideas, is then useless for cultivation, for they consider the manuring of the ground by the burning of a heavy mass of felled jungle to be absolutely necessary. By the middle or end of March the felling is over, and the hot April sun effectually dries the wood ready for the firing of the jooms in May. During this month the sky is hidden by dense clouds of smoke, miles of hillside often being ablaze the fire having spread from the jooms to the jungle. Any charred trunks which remain are dragged to the edge of the joom, and built into a close fence, for rats, jungle fowl, pheasants, deer, &c., would leave the poor Lushai but little of his crop if he did not take this precaution. Openings are left in the fence every now and then in which snares are set to catch unwary intruders. In spite of the utmost care, however, they often lose heavily from the onslaughts of these pests. In 1882 an army of rats, attracted by the seeding of the bamboos, which only occurs once in 50 years, marched through the country and having eaten the bamboo seeds made a clean sweep of all the crops. In spite of large quantities of rice being sent into the country by the Government of India, a large number of people died of starvation. One chief assured me that in his village alone 200 persons perished. These rats are said by the Lushais to have been of a different species to the ordinary jungle rat, and they speak with awe of the way in which they suddenly appeared from the north, marched through the hills, and as suddenly disappeared in the south. I have read of a similar invasion being made by troops of jerboa rats, and I imagine that the destroyers of the Lushai crops were of this species. While the jungle is drying, prior to the burning, the Lushais generally make an expedition to the nearest bazaar to buy the supply of salt required by their families during the rains. For many of them this means a journey of seven days each way.

About the end of May the whole family turns out to sow the seed; a line is formed at the lower edge of the clearing, and the party moves steadily upwards, scratching holes with their broad-bladed knives, and dropping a few seeds into each. Seeds of various sorts are occasionally sown in the same holes, and each comes up in turn. Rice is the chief crop, but melons, maize, pumpkins, millet, peas, beans, cotton, and tobacco are also grown. The maize ripens first and is eagerly expected by the improvident Lushais, who are generally hard up for food, having used more rice than was wise in the manufacture of beer. If a village has had bad crops, the people at once begin moving to some village where food is more plentiful, or the adults set off in large parties to buy rice wherever it is to be had. I once met fifty men and women returning to their village with rice they had bought; they had taken six days coming, and expected to be nine days on the road home. They had paid Rs. 2 for each load of about 60 lbs. While on the march they got food from the people of the villages where they slept, and would thus arrive at their homes with their loads intact. The rice obtained with so much labour was intended for the children who, they said, could not eat the wild yams and other jungle roots on which their elders could live. The rice harvest is not completed till near the end of December, though in the lower hills it is a little earlier. The Lushais consider a return of 50 fold as an ordinary crop, and when aspect, soil, and the season are all favourable, 100, and even 150 fold may be obtained. It is considered absolutely necessary to cut a fresh joom each year for rice, but maize can be profitably grown a second time in the same joom if the soil be good. The cotton grown in the hills is not of a very good quality, being rather short in the staple. The women, however, manage to spin it into a strong thread which they weave into a coarse but very durable cloth. About the end of October, there is not much to be done in the jooms, and the Lushai paterfamilias generally takes another trip to the bazaar to fetch salt, thread, needles, a knife or two, and other household requisites. Formerly they used to bring down ivory, beeswax, and indiarubber, but they have tapped all the rubber trees to such an extent that most of them have been killed, and our efforts at disarmament have reduced the number of guns with which they can shoot the elephants. Money is now more easily obtained, either by working for us or trading with the sepoys of our posts, and so the Lushais have given up bringing down such weighty articles to sell.

I should have mentioned that during the

rains the growth of the vegetation is so rapid that the crops require constant weeding, and, as the jooms are often some way from the village, the cultivators have practically to live in them at this season. A small house is built in the middle of each joom, raised high above the ground so as to allow of the watcher looking over the crop and frightening away birds and animals. At this time of the year the villages are almost empty, being chiefly inhabited by the old women and young children.

The rice is cut very high; as straw is of no value, it is threshed on the spot, and the grain stored in a circular bamboo bin in the joom-house. When the jooms are a very long way from the village, granaries are built at some convenient spot nearer, and the grain is moved into them. By the time all this is done it is January, and the Lushai has to think about his next year's joom.

Religion, as we understand it, the Lushais have none. They have no idea of sin or of a God who punishes sinners and rewards those who do well. It is very hard to find out what is the accepted belief, as there being no written language, almost every informer supplies one with a different version. However, there are two deities called "Pa-thien" and "Khuavang," although I once was told that they were both names for the same person. Pa-thien is generally said to be the creator, but he is not thought to take much interest in mundane matters, whereas Khuavang requires to be constantly propitiated to prevent him causing misfortunes. The Lushai does not, I think, trouble himself to form very clear ideas about these beings. Often, after looking at a watch or a piece of machinery, I have heard them say to each other, "The makers of these cannot be men, they must be Khuavangs." And once, when I was inquiring about such matters, I was told, quite gravely, that if I did not know all about Khuavang it was not likely that anyone else would, for that I was Khuavang. On another occasion, when asking about their theories as to a future state, I was told that all such matters were only dreams, and that everyone had his own opinion.

I think there are many Kuavangs—in fact, they would seem to be personal deities or spirits—as a man will tell you that his Khuavang is unfavourable when any series of misfortunes has occurred to him. A Lushai once told Mr. Murray, formerly Political Officer among them, that he once saw Khuavang. He had been drinking in the chief's house, and, in spite of his best endeavours, he could not get drunk. Being troubled at this, he went to his house, where he found a huge man, who, after looking at him solemnly for some moments, slowly faded away. Not long afterwards some great misfortune happened to him. Perhaps the beer had not been as harmless as he imagined.

The generally accepted belief regarding the hereafter is that there are two abodes of departed spirits, viz., "Piel-ral" and "Mi-thi-khua," or dead men's village. The first is the Lushai equivalent for our heaven. The qualification for admittance to it being success in battle or the chase, these being the only fitting occupations for a man. No woman can enter Piel-ral unless her husband takes her with him. Piel-ral is, of course, a comfortable abode, and the descriptions vary very much according to the ideas of the narrator. Mi-thi-khua appears to be merely a bad edition of this world, where the crops are always bad, and the gyal no larger than crabs. The river Piel flows between Mi-thi-khua and Piel-ral, which means the "Banks of the Piel." According to some, this life is only the first of three existences, after which people are annihilated, and sink like mist into the earth. Close to Cham-fai is a lake called Ri, which is said to be the road to Mi-thi-khua, because a man who was fishing there heard his wife's voice telling him that the eggs were in the basket of chaff over the fireplace. He returned home to find that his wife had died at the hour when he heard her voice, and that the eggs were safe in the basket.

There are no regular priests, but there are two kinds of people who are supposed to have dealings with Khuavang, or, at least, to be able to influence him, namely, the "Zawl" and "Pui-thiem." The Zawl is a person who, in his or her dreams, communicates with Khuavang, and is able to ascertain his intentions and obtain his assistance. It is considered advisable to keep on good terms with a Zawl, lest he should get Khuavang to trouble you. No woman can be a Pui-thiem, *i.e.*, "great knower." He is supposed to offer sacrifices in a manner peculiarly pleasing to Khuavang, and is much in request, as the Lushais' sole idea of curing any illness or healing any wound is to offer a sacrifice to Khuavang, and tie some part of the animal sacrificed to the part affected. The kind of animal to be killed depends on circumstances, and a Zawl is often consulted in the matter. A fowl seems sufficient for ordinary wounds,

and one frequently sees Lushais with a tuft of feathers tied round their hands and ankles to cure some slight abrasion. For the most serious matters, a black dog is necessary. Last winter, while on tour, we were caught in heavy rain, with the result that my Lushai interpreter had a bad attack of rheumatism, for which the doctor gave him some medicine; but the cure was not rapid enough to please the sufferer, who, therefore, paid a rupee and had a fowl sacrificed in the approved style. The next day he came to me triumphantly asserting that he had been completely cured. When I insinuated that it was the effect of the medicine, he shook his head, and said that our medicines did not appeal to the Lushai Khuavang. He explained that the pain in his leg was due to a spirit pulling him back by the leg to the hill where we had got wet, as every night since he had dreamt that he was there again.

Last April one of our Goorkha sepoys, while delirious from fever, escaped from hospital, and was lost in the jungle. Search parties were out in all directions for three days, without any result. Then one of the native officers came to me, and said that the night before some of the Brahmins had consulted their god, and he had told them that the missing man was a prisoner with the Lushai god. I remarked that I feared that by this time the poor fellow must be dead. "Oh, no!" he replied, "our god says that the Lushai god is looking after him, but that if he is not bought off by a sacrifice he will kill the man." The situation was new to me; and I asked him what he wanted me to do? "We wish you to send for a Lushai, who can make the proper sacrifice, and we will pay him anything he wants." To please the men, I sent off to the nearest village. Two old fellows arrived, and I explained the case to them; they appeared in no way astonished, and expressed themselves ready to do their best, only stipulating that they should not be held responsible if their efforts were not successful, which did not show much confidence in their powers. After some consultation, they said that the circumstances of the case pointed to a black dog being the proper victim. One was obtained, and after having murmured some incantations, one of the men slowly cut the poor beast's throat, while the other solemnly spat all around it. The next day the native officer came, with a smiling face, to tell me that the Sepoy had been found sitting by the side of the road, about two miles from Lungleh. The first account given by the absentee was that he had found himself in the jungle, and had wandered about till he found the road; but after a short time the story became far more exciting, and before I left it had grown into quite a respectable legend.

When concluding a political alliance, or when making peace, the Lushais take an oath of friendship as follows:—An animal—a gyal, for choice—is brought, and the contracting parties kill it together, either by shooting it at the same time, or by a thrust by a spear held by both of them. The blood of the animal is then smeared on their foreheads and feet, while they eat a piece of the liver, saying, "When the rivers run backwards into the earth, and not till then, will we fight, and till then we will slay each other's enemies, as we have slain this gyal." The oath used, when a man wishes to swear to a statement, is to gnaw a tiger's tooth, and say, "If I am not speaking the truth, may a tiger gnaw my bones as I gnaw this tooth." On the only occasion on which I have administered this oath, I regret to say, that one of the men undoubtedly was lying, but as both are in jail, the tiger has had no chance of showing which of them it was.

I was once present at an interesting Fanai feast, held to celebrate the establishment of a new village. When we arrived a very peculiar dance was in progress. The chief's wife was standing on a small platform with four handles to it, by which a number of old men and women carried her about the village. There was a handrail round the platform; without this the lady could not have maintained her position for a moment, for the bearers rushed about in the wildest manner, stopping suddenly, then dashing off in the opposite direction, lifting the platform now high above their heads, then lowering it almost on to the ground. The queen was dressed in a many-coloured cloth reaching down to her ankles; she wore a brass band round her forehead, from which stood up all round porcupine quills with green parrots feathers tipped with red tied to them; at the back of this band was fastened a short cross bar, from which hung strings of black and white beads with the green wing cases of beetles at the end of them. While being carried about in this wild manner the lady suddenly drew out a little white chicken from her havresack and threw it among the people. At once all the young men struggled desperately for it till the poor little creature was torn in pieces. After a little while she produced a

small piece of cotton-wool and threw it away but no one went after it; she then threw out a piece of red thread which again produced a struggle. I tried to ascertain the origin of this dance and the reason why the chicken and the thread were sought after and the cotton-wool neglected, but no one seemed to know. "It is our custom" seemed to them sufficient explanation. After this dance came the sacrifice of the gyal. This was certainly a religious ceremony, and is the only one of a devotional character which I have seen among the Lushais. A fine gyal was brought up and tied by the horns to a post, then the chief and an old man with a long white beard, a Pui-thiem, stepped up behind the beast and the old man began mumbling what was said to be a prayer for prosperity. At intervals they both filled their mouths with beer from gourds and blew it over the gyal's back. While the ceremony was in progress the onlookers did not maintain at all reverent attitudes, but talked and laughed as seemed good to them. When the prayer was over, the chief stepped up to the gyal and made a thrust at its side just drawing blood. He then ran into his house and was prohibited from crossing any running water for a month. The gyal was then thrown on its side and dispatched by a thrust from a sharpened bamboo. It was soon skinned and cut up, its skull being placed on the top of the post to which it had been tied. The next day there was another dance. Three men dressed in the finest cloths obtainable came up the main street treading a slow monotonous measure in time with the music of the royal band, which consisted of three men, one performing on a gong, one on a hollow bamboo, and one on a drum. Having reached the centre of the village the three dancers were regaled with beer by the ladies of the chief's household, then each in turn performed a *pas seul*, of a somewhat indecent character. During the whole time there was unlimited eating and drinking.

There are three feasts connected with the crops, these are called "Kut." One is held when the seed is sown, one when it begins to ripen, and the third is harvest festival. Each has its distinguishing name, but I regret to say I have forgotten them. I have only attended the first, a very monotonous performance. We arrived at the village about 10 a.m., and even at that early hour there was hardly a sober person to be seen; everyone of both sexes, and of all ages, had a bamboo full of liquor in his or her hand, which was replenished whenever necessary from pots of beer which were placed about the village. In front of the chief's house a circle composed of young men and maidens, with their arms round each others backs, danced round very slowly to a monotonous measure. In the centre of the circle were two men, one of whom chanted a few lines at intervals, the dancers taking up the refrain, while the other circulated the horn of beer. I believe the other two feasts are very similar; at the second one it is the custom to feed the children on eggs. In spite of all inquiries I could not find out the reason of this.

Marriage among these hill tribes is entirely a commercial transaction. When a young man takes a fancy to a girl, he either personally or by deputy sounds her parents, or her nearest male relative, as to what her price is; if he is fortunate enough to have the means to pay it at once, and thinks his charmer worth as much, there is no reason why the marriage should not be concluded at once. Among common people the only ceremony necessary is to give a drink to all friends of both parties, and then take the girl to his house. It is, however, very seldom that a young man has enough of this world's goods to conclude the bargain so quickly, nor is he often so much in love with the damsel as to agree to the first price asked, and much bargaining ensues. The price once fixed, the father-in-law generally allows payment to be made by instalments, and is by no means a hard creditor. In one case I heard of an old man, who had a grandson of two or three, using some money given him by the Political Officer to pay the balance of the price of his wife. In spite of this leniency the debt is never forgotten, and should the couple die before it is cleared off their descendants are always liable to be called on to pay the remainder. This is a frequent cause of quarrels, and in former times led to many raids, one chief attacking another, either to realise the price of his daughter, or to help one of his villagers to do the same. Occasionally, when a chief was unable to find the wherewithal to pay a troublesome father-in-law, he would start off to raid some unoffending village, generally in British territory, and pay off his debt out of the proceeds. This was the cause of the raid in which Lieutenant Stewart lost his life.

In some tribes the nearest male relative on the mother's side also demands some payment for the bride. When a chief marries there is a three days' drink in the house of the girl's

father, and on the third night the happy couple are considered duly married.

As a rule, a chief marries the daughter of another chief, and of course her price depends on her father's power. I have heard of a case where a princess was valued at 10 gyal, a gun, and some cloths, equivalent to about Rs. 600; an ordinary wife may be purchased for Rs. 80 to Rs. 100, according to her charms. In these the practical Lushai includes her capability to carry wood and water, and perform the other arduous duties of a Lushai housewife; for the Lushai man thinks that if he cuts the joom, helps to weed it, goes to the bazaar, builds and repairs the house, and goes on shooting expeditions, he has done quite his share of the work. The carrying of loads of any sort is considered peculiarly woman's work; and now that the Lushais have learnt to trust us, if a man is called on to carry part of the baggage of our escorts on tour, he will often have his wife to meet him half-way. On one occasion, as the woman was manifestly unfit to carry the load allotted to her husband, the officer insisted on the man continuing to carry it. One of the onlookers was heard to remark, "Surely he does not know that she is his wife."

Although most of the hard work falls to the share of the women, they are by no means looked on as mere slaves; on the contrary, the opinion of the wife is asked on every matter, and more attention is paid to it than in many more civilised regions. A Lushai may have as many wives as he can pay for, but few, except some wealthy chiefs, can afford more than one such luxury. In cases where a chief has several wives it is usual for each to have her separate establishment. Besides his regular wives, a chief sometimes has one or two concubines, whose children are not considered chiefs; but if any of them grow into particularly capable men, their father may give them some houses, and if they govern wisely their birth will never be thrown in their teeth. As a rule, each son of a chief is given a few houses as soon as he is married; but now that we do not allow the stronger to seize the land of the weaker, many a young chief has to stay in his father's village for want of a place to move to. The youngest son is an exception to the above rule, remaining in his father's village, and succeeding him at his death. He is then looked on as the head of the family, and inherits the necklaces, gongs, and other heirlooms. When a woman dies, any necklaces, &c., that she has had from her own family always return to it, in the person of this fortunate youngest brother. Among the common people the laws of succession are much the same, but not so strictly observed. In no case can a woman own property or slaves. If a man dies without any male issue, his youngest brother is his heir, but has to support the widow and children. Chastity before a woman is married is not considered necessary, but should a child be born, the lover, if he does not marry the girl, must pay her father a gyal. The child remains with its mother till it is old enough to work, when the father claims it, which seems hard on the mother, especially if the child be a girl, for whom the rascal of a father may perhaps get a big price.

After marriage the women are very chaste. The punishment for adultery is not as severe as might be expected. The woman is turned out of the house, and her relations have to pay back the price they received for her. In one case which came to my notice, a chief's widow listened to the blandishments of a gay young spark. Her late husband's brother sent her back to her father, demanding from him the price that had been paid for her, and also the custody of her children. I believe some tribes in the hills punish a woman who commits this offence with death. The male culprit, unfortunately, escapes scot free. Should a man wish to be rid of his wife, and have nothing to accuse her of, he may send her back to her father with a suitable present. The folklore of the Lushais is very voluminous. Colonel Lewin, the author of "The Fly on the Wheel," who is still spoken of by the Lushais as the greatest of all the white men, has written down a few of these legends, word for word, as they are told round the fire of an evening, with excellent translations; but there are many more waiting to be recorded, such as these following.

While on tour I once entered an open valley (an offshoot of the Van-lai-phai), on the opposite side of which there were several large black boulders, which resembled gyal lying down. I pointed out the resemblance to a Lushai, and suggested that the valley should be called "The valley of the stone gyal." He laughed, and said, "Why, it is always known as the valley of Shura's gyal." On inquiry, I found that Shura was a mythical hero of immense size, who in bygone times had lived in that part of the country. He was herding his gyal in this valley at the time of the Thimzjing. This was a period of fearful catastrophes

—dense darkness covered all the earth—all the trees dried and rotted; tigers devoured all the human beings, and Shura's gyal were turned into those stones. After a time, a new sun shone out, and a new race of human beings came forth from out of a cave. Further on I was shown the stream in which Shura had washed his yams; and on the top of a hill, some five miles away, I found a curiously shaped stone, which I was told was the head of Shura's mallet, which had broken off, and flown across here while he was levelling the ground for his gyal to feed on. Shura appears to have been a buffoon. One day he announced his intention of going crab-hunting in the territory of a hostile tribe; this astonished his neighbours, for Shura was not famed for his bravery. Presently they found him scrambling about under the house, and exclaimed, "We thought you were going to our enemies' land." "This is the enemies' country," he said, "let me out! let me out! for the pigs' doorway is not wide enough for me." They demurred, and Shura promised them unheard of wealth, if they would let him out, which at length they did; whereupon he laughed at their credulity. They asked him what he had caught? and he produced a frog, which he declared was a crab, and proceeded to put into a pot of water on the fire. Someone took the lid off the pot, and out hopped the frog on to his grandmother's leg. "Wait! wait! Don't touch it! I know how to catch it!" shouted Shura, and picking up a huge log of wood, he smote so hard that, missing the frog, he broke the poor old lady's thigh.

Another of these mythical giants is called Mual-savata, the smoke of whose pipe was great as that of a joom burning. Once on tour I was shown a stone about 2 feet long, 12 inches wide, and 9 thick, which had evidently been squared by hand, and was told that it was Mual-savata's whetstone, which had dropped out of his havresack through a hole which his wife had neglected to repair.

The Lushai version of the flood is that Water fell in love with a beautiful damsel, who repelled his advances, and pursued her from one hill to another, till at length he surrounded her and the other human beings on the top of a high hill. The people expostulated with Water on his unusual and unreasonable behaviour, whereupon he explained that he wanted the girl, and that he would go away if she were given to him. After a brief consultation, during which the flood continued to advance, the people threw him the girl, and the flood at once began to abate.

Nine miles from Demagri, on the Lungleh road, the traveller has to cross the Tui-chong river, one of the largest tributaries of the Kurnaphuli, on which Chittagong stands. This river, according to the Lushais, owes its origin to the self-denial of a girl called Tui-chongi, who, with her little sister Nuengi, was walking on the hills whence the river rises. It was April, and the sun blazed down on them. Nuengi began to cry for water. "How can I get you water on the top of a hill? Don't you know that all the springs are dry, for are not the jooms ready to be burnt?" "Water! water! or I shall die," wailed Nuengi. "Would you rather have water than me?" asked Tui-chongi. "If I don't get water, I shall die, and then of what use would you be to me?" replied the spoilt child. So Tui-chongi, to satisfy her youngest sister's thirst, changed herself into a river, and Nuengi drank and was satisfied. But the water flowed down among the hills and burst its way into the country of the Bengalis. The king of the Bengalis was astonished to see so mighty a river flowing past his palace, and sent some of his people to find out whence it came. They journeyed many days, till at length they reached the source of the stream, and there sat Nuengi, who, now that her thirst was satisfied, would gladly have had her sister back again to show her the way home. The explorers were astonished to find so beautiful a maiden sitting thus in the middle of the jungle, and decided that it would be wise to take her back to their master, who liked pretty girls. So Nuengi was added to the harem of the king of Chittagong, and in time became the mother of a most lovely boy. The king's chief wife, on seeing the child, thought to herself, "If my lord sees this jungle woman's brat, he will assuredly love her more than me, who am childless." So she had the child thrown into the river, which flowed under the palace windows, and frightened Nuengi into keeping silence on the matter. Tui-chongi, however, in spite of the change in her circumstances, remembered her little sister, and cherished the child so that he grew and throve. In the same way six more children were born and thrown into Tui-chongi's fostering arms. When they were grown up Tui-chongi told them the circumstances of their birth, and sent them to dance on the

roof of their father's palace, who hearing the noise came out to see the cause of the disburbance. When he saw seven handsome young men he was much astonished, and asked them who they were. "We are your sons," they replied. "Why do you lie to me?" said the king; "liars have short lives in my kingdom." "Nay, O king, we lie not; we are Nuengi's sons;" and they told him their story. So the king smote off the head of the bad queen, and installed Nuengi in her place.

Such are some of the stories which serve to pass the time round the camp fire after the day's march is over. They are told in the same words each time, and the hearers evidently know them nearly as well as the narrator, for you see their faces light up in anticipation of the joke which they know to be coming.

I have tried to place before you the Lushais as I have found them during the six years that I have spent in their country. I am aware that the account is far from complete, but I trust that what I have said will enable you to form some idea of this country, one of the most recent additions to our empire, and to understand some of the peculiarities of its people.

As to their future, let us hope that they will follow in the steps of the Cossiahs, a tribe on the Assam border, who, a comparatively short time ago, were quite as savage, but who are now loyal, law-abiding citizens, eager for education, and anxious to serve the Government they once regarded as their deadly foe.

I am indebted for the photographs, from which the slides illustrating this paper have been made, to Lieutenant Watson, 2nd Battalion 2nd Goorkha Regiment, Mr. Plowden, and Mr. Hutchinson, of the Bengal Police.

DISCUSSION.

The CHAIRMAN said:—I am sure I only interpret your sentiments in thanking both the writer and Mr. E. O. Walker, who has been so good as to read to us this highly interesting paper. It is a storehouse of observations interesting and useful both to the folk-lorist, the anthropologist, and to the administrator. One thing that struck me very much in the paper is the assured way in which Captain Shakespear speaks of the work of pacification being practically done, and of our having little more trouble to look forward to in order to bring these head-hunting savages into the ways of peaceful industry. He uses an illustration which struck me all the more, as it was one I had ventured to use in a spirit of prophecy some six years ago, when recommending to Lord Lansdowne's Government the policy that has now been adopted, of controlling these tribes from within. I pointed to the Khasias, of whom the plains-villages, and our Sylhet officers had been in the same dread as we of Lushais, and who, by a policy of a central post dominating them in their midst, and of roads from end to end of the country, had come to be a peaceful and thriving race, living under their own chiefs, and with the head-quarters of the Assam administration in their midst. They have proved to be quick to learn and ready to obey, and a country which, from being a closed terror to all, is now the delight and happy hunting ground of the solitary entomologist, botanist, and lover of scenery, and I foresee a similar future for Lushailand. Captain Shakespear has touched but lightly on the past history of our dealings with the Lushais. It has, till quite recently, been one of comparative failure, and I hope I may be excused for dwelling a little on it, and on the changed circumstances which a few years ago rendered possible and expedient a change of policy. We meet, in the official annals, with raids by Kukis on Sylhet and Tipperah villages in 1819, and one, which subsequent events showed to be by this Lushai branch of the Kukis, attracted some attention in 1826, but the actual name Lushai, or Luchye as he spells it, appears first, I believe, in a report, by Colonel Lister, of 1853. McCulloch, the Resident at Manipur, reported in 1847 on the increasing ferocity of Kuki raids. There had been a raid on the Sylhet frontier in 1844, in which twenty villages had been slaughtered, and there were others in 1847, 1849, and 1850. But most of these raids appear to have been on outlying villages of Kukis and Manipuris who had come within our settled jurisdiction for the sake of protection; and it is clear that for a long time we regarded these villages, not as they really were—a bait to invite Kuki raiders—but as a protection to our settled cultivators in the plains. Both McCulloch and Lister, writing at this time, notice as a special feature in the movements of these tribes, that successive waves from the south and east came up and attacked the tribes to the north, who were consequently either dispersed or settled within our borders or those of Manipur. We have still in North Cachar villages of Kukis, who have crossed the whole valley of the Barak and settled in the hills beyond from fear of their southern relatives. We made not unfrequent attempts to punish these raiders by spasmodic counter-raids, without much knowledge of whether, if successful, we were hitting the right man, but generally without success, driven back, not by the arms of the enemy, but by rain, sickness, and want of supplies. There is a record of an expedition under Captain Blackwood, in 1846; of another under Colonel Lister himself, in 1850, who mentions in his report what, if true, is very singular, viz., that the Lushais had with them a force of 300 Burmese auxiliaries or mercenaries, which was accounted for

by the supposition that the Burmese, when driven by us out of Cachar and Manipur, had not all returned to Burma, but had many of them settled in Lushai villages. In this report we first come across the name of Sookpilal, a chief of whom some 20 years later we heard a good deal. Other important raids, in 1868, were followed by a more pretentious expedition, under General Nuttall, but with no more lasting success than those of earlier years. But while these things had been going on along the northern frontier of Lushailand, *i.e.*, on Sylhet and Cachar, similar events were occurring on the south and south-west borders in Akyab and Chittagong. There we called the raiders Shendus instead of Lushais, and Chins instead of Pois, but they are all clans of one people; and I shall be very much obliged, indeed, if anyone here to-night can throw a little light on the question of what people they are, and what are their ethnological and linguistic affinities. Well, on the Chittagong side we hear of Shendu raids as far back as 1847. The expedition of Lieutenant Hopkinson in that year from Akyab led to no result, except a very graphic and interesting report, which gave Government more knowledge of the question than they had before, and brought to notice an officer who afterwards rose to distinction. Raids went on continually on the Chittagong side. In 1854, a report was recorded showing 19 raids in 17 years, with an accompaniment of 107 persons killed and 186 captured, besides the burning and plundering of villages which these things entailed, and it must be remembered that these raids were in no way retaliatory or provoked, but made simply for the sake of heads and captives—heads to honour a dead chief, and captives to pay a bride's dowry. To find a remedy was difficult, and military expeditions were discountenanced because of the difficulties of the country and climate and their want of success. The idea of subsidising the chiefs and enlisting levies was proposed, but not adopted. The plan of a series of defensive posts along our own frontier was similarly rejected, though later on a combination of these policies was in a half-hearted way carried out. In 1860 came what was known as the great Kuki invasion, in which the raiders went well into the settled country along the valley of the Fenny, and burnt and plundered fifteen villages, with a record of 185 killed and 150 captives taken into slavery. Fortunately on this occasion the chief, Rutton Poea, who was responsible, lived near our frontier, and an expedition was sent against him under Captain Raban, which was successful. He submitted and signed an agreement with us, which, to a moderate extent, he adhered to, and he was certainly of great use to us afterwards. Certain other chiefs signed agreements at the same time through his influence, but these came to nothing. This occasion, however, introduced the era of annual meetings with the chiefs, which, under Captain Lewin on the Chittagong side and Mr. Edgar on that of Cachar, developed greatly later on, and obtained for Government the standpoint of knowledge without which our subsequent action would have been impossible. Things went on in this way till 1871, when the great raids on the southern borders of Cachar and Sylhet took place. The tea gardens of Cachar bore the brunt of these, though Sylhet and Manipur also suffered. Of our own people, the tale of dead was over 120 and of captives not much less; and all this while the Magistrate of Cachar, Mr. Edgar, was the guest, so to speak, of the principal Lushai chief, Sookpilal, whose relatives, if not himself, were certainly implicated in the raids. Why did they not kill him? It is suggested that Sookpilal's people, who raided Sylhet, thought that they were in no way injuring the Magistrate of Cachar, looking on the two districts as separate kingdoms like Munipur and Tipperah. The fact may be true, but as an explanation it leaves much to be desired. On this occasion Government took up the question seriously, and sent out properly organised and equipped expeditions, one from Cachar under General Bourchier, to which Mr. Edgar was political officer, and Major (now Lord) Roberts was Quartermaster, and another from Chittagong, to which Major Lewin was attached. These two expeditions were quite successful. They penetrated into the centre of the tract and practically joined hands, easily overcame opposition, and dictated terms which were agreed to. After this expedition we hear no more of raids on our territory for another fifteen years, when a new generation were growing up. In the meantime, the policy laid down by Government, and carried out, as far as possible, by its officers, was one of a chain of defensive posts all along the exposed portion of the frontier, and on the other side frequent visits between the frontier officers and the chiefs, the encouragement of trade by subsidising bazaars, and the development of friendly relations. This peace, which had lasted for 15 years, was rudely broken in 1888, which saw three disastrous raids on the Chittagong frontiers: first, one in which Lieut. Stewart, of the Leinster Regiment, who was out on surveying duty with two non-commissioned officers near the Chittagong frontier, was killed; secondly, a raid by a quite distinct party on the village of the Pakuna Rani, which was within four miles of our frontier post at Demagiri (and which showed the uselessness of these posts in the dense jungle—like lamposts in a London fog—to check raids), in which 22 were killed, and 15 captured; and, thirdly, a much more disastrous raid in the Chengri valley of the Chittagong hill tracts, where a body of Lushais from the north raided at will for three days, destroying 24 villages, killing over 50 of our subjects, and carrying off 80 more. This disastrous series of raids led to a reconsideration of the whole question. The uselessness of defensive posts to prevent armed Lushais from getting behind them was conclusively proved; and the system of making friends with the chiefs (good, so far as it went), touched only the fringe of the country, and had no effect on the powerful chiefs in its interior; and, above all, the

whole situation had been changed, by the annexation of Burma and the establishment of a settled government on the western frontier of Lushailand. Formerly the Lushai hills had been a real frontier. To have gone in there would have brought us into contact with the Chins to the east, who, though uncontrolled by Burma, would have posed as Burmese subjects; and of the country beyond them, we had known nothing; now things were changed. We had peaceful villages, and our own police posts to the east, as well as the north and west of the tribes, and Lushailand thus became an *enclave* of head-hunting savages in the midst of our settled districts. This could no longer be permitted; and it was decided to dominate the country by central posts situated on the hills, by connecting roads, and by the control of political officers living in their midst. This policy has been gradually worked out. It has not been done without a good deal of fighting and much loss of life, nor without a great deal of very harassing work, but it has been done effectually. The Assam Government has established its outposts among the northern Lushais, the Bengal Government among the southern Lushais, of whom you have just been hearing, and the Burma administration has its posts among the Chins to the east. From these posts parties are sent out, and the tribes have learnt that opposition to them is useless, and, above all, they have learnt that the three Governments are one. Two years ago, when the Superintendent of the Northern Lushais was in danger, Captain Shakespear, from the south, went to assist him. He, in turn, was surrounded, and was rescued from a difficult position by a force from the Burmese post of Fort White. It is quite possible that there may yet be further trouble; savages do not change their nature in a day; but the time when every year saw our peaceful villages burnt, and their inhabitants slain by the score, and carried off into slavery by the hundred, are past and gone, and I look forward confidently to the time when these hills will be as peaceful and orderly, and their inhabitants, I hope, as prosperous and contented as those of the Khasia hills. Similar work is going on successfully among the Garos and the Nagas. It is a problem which costs labour, time, and money (for, from an economic point of view, it is unlikely that these wild hills will even pay their expenses), but we have found the key to its solution, and it is a work for which the country should be grateful to the young officers, like Captain Shakespear, who, with their lives in their hands, spend their best years, far away from all the amenities of life, in introducing the blessings of peace and civilisation among the barbarous tribes of whom you have had such a graphic account from his pen to-day.

Mr. H. Risley, C.I.E., said he was not in a position to throw any light on the Lushais themselves, but he should indicate a line on which it was possible that within a reasonable time some information might be obtained, and it might be interesting to state the lines on which work had been going on in India for some years past. For a considerable time it was rather a reproach against the Indian Government that they had done practically nothing since 1811 to make available the tremendous stores of ethnological facts which were to be found in India. About ten years ago, however, the matter was taken up in connection with the census, and was developed on two lines. First of all there was an inquiry into what people generally called ethnography, that is to say, customs of every kind, including marriage, religion, folk lore, and so forth; and, secondly, the physical characters of the people. Working on those lines, they did not attempt to go by their own light, but were guided by Sir William Flower, the best English authority, and Dr. Paul Topinard, the best French scholar. The inquiries brought out the fact that in India itself, taken from the eastern frontier of Bengal up to the north-west frontier, you could trace two tribes—a fair race and a black race—and it seemed to be proved that the black race were the aboriginal people, and of a type which more or less approached that of the negro, while the fair race were of a type more ordinarily called Caucasian. Along the borders again the type was Mongolian. The word Turanian, which was used in the paper, was, as had often been pointed out, in some respects an unfortunate word, because it had always been used in connection with linguistic characteristics only, and in dealing with physical characteristics, the word Mongolian was more satisfactory. These results having been obtained and accepted by the various authorities, a further step had since been made in the form of a scheme, which was adopted three or four years ago in consultation with two very high authorities, Professor Robertson Smith and Mr. J. Fraser, both of Cambridge, and recommended to the Government of India by the University. Under that they had now in all the chief provinces committees which took up questions of customs and physical characters on a regular plan, and from time to time papers had been published, and more would he hoped soon be published. Taking the Lushais from this point of view, it was apparent to him from the paper that Captain Shakespear had not yet been addressed on the subject by the officer in charge of these questions of Assam, but there would be very little difficulty in bringing the points to his notice, and he was evidently so well qualified for dealing with the people and gaining their confidence that extremely interesting results might be anticipated. The points he would find of greatest interest, judging from what happened in other places, would be the various sub-divisions of tribes in connection with marriage customs. These lay entirely below the surface, and it was exceedingly difficult to get at them. The questions must be put with great care, and by someone who had the confidence of the people. It was found, for instance, in a large portion of the West Bengal that all tribes were divided into

sub-divisions according to the names of animals, and the correspondence between those tribes and those of the North American, such as the Iroquois, was so precise that you only had to change the animals, as, for instance, where the Iroquois had a bear the people he was thinking of had a lynx. The other point was that of physical measurement, and on that again there would be no difficulty; certain measurements brought out certain characteristics. Taking them as Mongolian people, which he thought they were justified in supposing they were, their heads would be measured in the first instance, and he should anticipate they would be found to belong to the great division called broad-headed, where the width of the head was more than 80 per cent. of the length. He should also anticipate they would be found to have certain other characteristics, which could be brought out very clearly by measurement of the cheek-bones and the orbits of the eye. These measurements worked so clearly in Darjeeling that it was found if you took a series of tribes, and arranged them in the order of social precedence, that order would correspond with that which you got from the actual measurements, of course taking averages. The tribes which by measurement appeared to have a large amount of Mongolian blood stood at the bottom of the social scale, and at the top the tribe which had the most Hindoo blood, and that again had the least Mongolian physical characteristics. Further in the Chota - Nagpur country, where the negro-like race was very strong, the indications were so precise that you could say that a man's social position varied inversely as the width of his nose, the broader or more negro-like his nose the lower his caste, and *vice-versa*. Again, the subject of religion did not appear to him to have been quite worked out. He should have expected there would be a great deal more to be said about it, and that in particular these people had many more gods. Whether it was that people supposed that a race could only have one god he did not know, but there were a great many instances on record where the generic name which meant gods had been mistaken for the individual name meaning one word, and, judging from what one found amongst other people of the same kind, he would expect to find here the system called animism, which was not a very satisfactory term, where everybody believed that he was compassed about by an infinite number of uncomfortable powers, each of which had its own department. One ran cholera, another small-pox, another cattle disease, another fever, and so forth. Others, again, inhabited rivers, and washed people down with floods, others dwelt in the hills, and brought down mud avalanches, landslips, and so on, and these powers had to be propitiated. He happened to know, from a great authority on these subjects, Sir John Edgar, that in Manipur gods of this type undoubtedly did prevail, for he told him the story of a god there, a very powerful god, but it was also blind. His department was fever, and it was very necessary to propitiate him, and the offerings were put on the tops of the hills. Fowls were what he liked best, but the people there used to take a very big basket, and put into it a very small chicken, because they said as he was a very blind gentleman, he would feel the big basket and think what pious people they were to give him such a big fowl; being blind, he would not be any wiser. He should expect to find a belief in these so-called animistic gods to prevail amongst the Lushais. One instance that struck him was the tiger oath—the Lushais apparently swore by the tiger. He was once in a sub-division where, in front of the court-house, a large tiger's skin was hung up, and the oath taken by the witnesses ended with the words, "May the tiger eat me." The moral to be drawn from that and other cases was that custom travelled like myth, and it was extremely unsafe to argue that, because people had the same curious customs they were necessarily related. The same applied to the institution of Bachelors' Hall. That was a very prominent institution in Chota-Nagpur. He did not know that it had ever been explained, or what the object of it was. He would undertake that the requisite materials for following up any clues which could be found in this most admirable paper should be laid before Captain Shakespear, and he had not the least doubt that he would add very largely indeed to their knowledge of the Lushais, because he had made a most important step already.

The vote of thanks was then carried unanimously, and the proceedings terminated.

FOREIGN & COLONIAL SECTION.

Tuesday, January 22, 1895; EDWARD CUNLIFFE OWEN, C.M.G., in the chair. The paper read was "Russian Armenia, and the Prospects for British Trade therein," by Dr. A. MARKOFF.

The paper and discussion will be printed in a future number.

SEVENTH ORDINARY MEETING.

Wednesday, January 23, 1895; Surgeon-General DE RENZY, C.B., in the chair.

The following candidates were proposed for election as members of the Society :—

Burgess, G. Douglas, C.S.I., Judicial Commissioner, Upper Burmah, Mandalay.

Harris, Francis Eldred Lodge, 75, High-street, Chelmsford.

Hurtzig, Arthur Cameron, 2, Queen-square-place, Westminster, S.W.

Jenkins, David, Abbot's-hill, Llandilo, Carmarthenshire.

Laughlin, Robert C., Gortin, Newtownstewart, Ireland.

Lloyd, Christopher, 1, Invicta-villas, Balmoral-road, New Brompton, Kent.

Speller, James, 61, Golden-lane, E.C.

Story, William Henry, 83, Alexandra-road, South Hampstead, N.W.

Williams, Alfred Goodinch, London Institution, Finsbury-circus, E.C.

The following candidates were balloted for and duly elected members of the Society :—

Hedgman, W. James, The Firs, Upper Richmond-road, Putney, S.W.

Mayer, Daniel, 18, Great Marlborough-street, W.

Phillips, Charles George Washington, Grey Friars, Boston, Lincolnshire.

The SECRETARY announced that Sir Alexander Wilson was suffering from an attack of influenza, and was therefore, to his great regret, unable to take the chair.

The paper read was—

TEA.

By A. G. STANTON.

There is no civilised country in the world in which so large a quantity of tea is used as in the United Kingdom of Great Britain and Ireland. The quantity we annually consume nearly equals that of all other civilised countries combined. The people of these islands are the greatest tea drinkers, and wherever the British flag is unfurled tea consumption invariably follows. To the English-speaking race, tea drinking seems almost as natural as the mother tongue. In our own native land, perhaps there is nothing besides water so generally drunk, rich and poor, old and young, all contribute their quota to its use, but perhaps those who excel in its consumption, and even derive most enjoyment from it, are the fair sex; and to deprive ladies of their afternoon tea would produce little short of a social revolution, while many people would not think the day properly begun if they did not have their cup of tea before beginning their daily work. Whether the country be rejoicing in affluent years of plenty, or impoverished by adversity and distress, the use of tea continues uninterrupted, and neither strikes nor distress appear capable of checking the steady increase in its annually progressing consumption.

To the National Exchequer, tea has been an untold boon, and the increased revenue annually derived from it must have proved a consolation to many a Chancellor of the Exchequer. Perhaps no tax is more cheerfully paid or more imperceptible in its weight than the small duty upon this universally favourite beverage. Its price has, for the past half-century or so, continued steadily to decline, until it has become a necessity in the household of rich and poor alike, and has so ingratiated itself into our homes, and even our hours of toil and work, that it seems to have become almost a part of our national existence. Were the supply of tea suddenly to cease, it would bring consternation to many a family, and sadness to many a cheerful fireside.

The national character of tea drinking is at once apparent when we remember that the small population of the United Kingdom annnally uses nearly as much tea as that of the whole Continent of Europe, North and South America, Africa, and Australia combined, which totals perhaps fifteen times the number of people our islands contain. Every day in the year we use, on an average, nearly 600,000 lbs. of tea, the approximate amount of liquid thus consumed reaching, probably, 4,000,000 gallons daily.

The vicissitudes which have taken place in the public taste concerning tea have been very remarkable. The green tea of our grandparents has almost ceased to be known in this country, and the Twankay, Hyson, and Gunpowder, with the old black tea called Bohea, are seldom if ever heard of, and perhaps hardly even understood outside the tea trade itself, while the more modern names of Kaisow, Lapsang, and Moning are far less common than they were even ten years ago, so completely has the public taste changed, until even the produce of the Chinese Empire itself, which at one time met almost the whole of our wants, does not at present constitute more than about one-tenth of our supplies, so eneral has become the use of Indian and Ceylon tea.

But the increase in the use of tea was for many years very gradual. In the year 1800 we consumed only 20,358,827 lbs. The following figures show the progressive consumption from the beginning of the century :—

	lbs.		lbs.
1800	20,358,827	1860	76,800,000
1810	24,486,408	1870	118,000,000
1820	25,712,935	1880	158,321,572
1830	30,046,935	1890	193,949,452
1840	31,716,000	1894	214,341,044
1850	51,000,000		

In 1800 the average consumption per head of population was 1·25 lbs.; in 1864 it had increased to 2·95 lbs.; and in 1894 to 5·53 lbs.

The Gradual Decline and Fall of the China Tea Trade in Great Britain.

Indian Tea.—Up to the year 1862 practically all the tea used by us came from China, but after that date the consumption of Indian tea became a growing feature of the industry. The progress it made was, however, for many years very slow. Thus, in 1864 only 2,796,000 lbs. were used, or 3 per cent. of the entire consumption; in 1870 the quantity had only increased to 13,500,000 lbs., or 11 per cent. of the whole; and in 1879 to 34,092,000 lbs., or 22 per cent.

The year 1879 marks an epoch in the history of the tea industry, because up to and including that year the home consumption of China tea continuously progressed and suffered little if any apparent check from the increasing use of Indian tea.

But the year 1879 marked the maximum consumption of China tea in Great Britain. Since that year its use has steadily declined, the increasing quantity of Indian tea imported into the country from this date beginning very perceptibly to interfere with the use of China tea. It soon became evident that a fearful struggle was about to take place between the two industries. Tea came pouring in from both countries, and the price in consequence fell lower and lower. More tea was being imported than was wanted, and oversupply was gradually crippling both industries, and it appeared as though either Indian or China tea would in course of time be crushed out of the market.

Rise of Ceylon.—It was while this struggle was becoming acute that Ceylon suddenly entered the field. But her imports were at first so small—so insignificant—that little heed was paid to them. In the year 1880 only about 100,000 lbs. were used, and in 1885 the quantity had only risen to 3,217,000 lbs., but from this date for several years, progress was astonishingly rapid, the consumption rising in 1886 to 6,245,000 lbs., in 1887 to 9,941,000 lbs., in 1888 to 18,533,000 lbs., in 1889 to 28,500,000 lbs., and in 1890 to 34,516,469 lbs., in 1894 to 71,570,078 lbs. It has thus continued to increase almost without a single check, every year showing a larger consumption than the previous year.

The reason of its more rapid progress than Indian tea is traceable to the fact that the latter was for many years blended with China tea, its great strength being used to add body to the weaker tea from China. This process of admixture of Indian tea had been in progress for many years before Ceylon tea had been introduced, each year witnessing a larger proportion of Indian tea in the blend. Ceylon tea was found to be somewhat similar in character to this blend of India and China tea, which at that time was very rapidly gaining in popularity. Hence an article similar to that which was being produced by the admixture of Indian and China tea was found ready made in the produce arriving from Ceylon, and its progress was naturally exceedingly rapid.

Struggle between British-grown and China Tea.

As Ceylon continued to pour these annually-increasing quantities of her tea into the market, the struggle became a sort of triangular duel. There was evidently no room for the three suitors to public favour, and it was apparent that one, at least, must succumb.

Enough for years past had been said and known about the impurities of some of the teas from China, and the epithet "lie tea," was a well-known expression as referred to certain teas manufactured in China, whereas no taint of any kind had ever sullied the reputation of either Indian or Ceylon tea. These teas—instead of being manufactured, as was the case in China, by the unclean and objectionable process of hand labour, aggravated by the heat of almost tropical weather, —were made by machinery; a much more cleanly and salutary mode of operation.

In addition to this, as most of the finest Chinese tea was always taken by the Russian market at high prices, we received less and less of the best China tea into this country; and indeed the general quality of China tea all round fell perceptibly, and continued much below its ancient standard.

Economy of Indian and Ceylon Tea.—Besides this, it was found that the teas from our own dependencies were more economical than those grown in China because, being stronger, they would go farther. In other words, it was unnecessary to put as much Indian or Ceylon tea into the tea-pot as China tea. Money was thus saved by using Indian and Ceylon tea, in addition to its being more palatable; and what stronger inducement could there be to a nation of practical people?

Hence the battle gradually turned in favour of Indian and Ceylon tea. For the introduction of machinery, European intelligence and skill, enabled India and Ceylon to rapidly and steadily reduce the cost of production. Thus, it soon became evident that these qualities, pitted against the obstinate barbarity and the ignorance of the Chinese in adhering to their antiquated notions of cultivation and manufacture, must triumph sooner or later.

Falling-off in Tea Duty.—About this time, 1885-1889, a very curious circumstance was taking place, which caused some trouble to the Chancellor of the Exchequer. Though afternoon teas were perhaps more in vogue than they had ever been before, and tea drinking had become so general that even the medical faculty were crying out against its possible abuse, the tea duty, instead of bringing in a better revenue every year, suddenly became almost stationary, and continued so for some four or five years, and yet less tea did not seem to be drunk. This extraordinary circumstance induced some of the high officials at the Custom-house to try experiments with Indian and China tea, and after doing so they wrote in the Customs' report:—

"From the information which has been afforded us on the subject, we believe that we make a moderate estimate in assuming that Indian tea goes half as far again as Chinese tea, so far as depth of colour and fulness (not delicacy) of flavour are concerned.

"Thus, if 1 lb. of Chinese tea produces 5 gallons of tea of a certain depth of colour and fulness of flavour, 1 lb. of Indian tea will produce $7\frac{1}{2}$ gallons of a similar beverage."

This is practically what the British housewife had found out years before, for is their not an unwritten law in every house that tea must have a certain colour, and that if, when poured from the teapot, it is too pale, it must be allowed to stand a little longer? The same Custom-house report also pointed out that the displacement of Chinese tea by that produced in India and Ceylon was practically tantamount to a reduction of duty on Indian and Ceylon teas. Soon after this, on May 1st, 1890, the duty on all tea was reduced from 6d. to 4d., a step which, in the long run, has proved beneficial alike to the National Exchequer and to the public. Directly the displacement of China tea became slower, or was temporarily arrested, the use of dry tea immediately increased.

At the present time Indian and Ceylon teas have displaced all but about 26,000,000 lbs. annually of China tea, and even this small quantity seems to have but a precarious hold, so completely is the market dominated by the prevailing taste for Indian and Ceylon teas—the total quantity of Indian tea having gradually risen until, in 1894, it reached 117,000,000 lbs., and that of Ceylon until it reached, in the same year, 71,500,000 lbs., against 26,000,000 lbs. of China; the per-centage of British-grown tea being thus 88, against only 12 for China and other countries. The annual progress of Indian and Ceylon tea, and gradual decay of China, is traced in Table I. (p. 192), which also shows the percentage used in each year

The gradual fall of the China tea trade in this country may thus be traced to several causes; but the whole can be summed up in the one great and all-important reason, viz., the triumph of civilisation over barbarism; for melancholy though it is to see a great industry crippled, and well nigh obliterated, in so important a market as Great Britain, and to remember the unfortunate troubles which the event must have brought upon thousands of human beings, and the heavy losses entailed even upon our own countrymen and our commerce in the East, it is, after all, but a natural circumstance that the intelligence, science, and research, which are the outcome of European civilisation, should reduce to impotence the obstinate conservatism which for centuries has characterised, and even now characterises, the Chinese Empire.

It is not improbable that the present war in the East may conduce to a greater displacement of China tea in other markets than those of Great Britain. The injury resulting to Chinese commerce, in the loss of so important a tea market as Great Britain, has now been followed by a terrible national military disaster; and both these troubles are, in a measure, due to China's refusal to allow the civilisation of Europe to penetrate her country. May the result of the present war, with its terrible lessons to this great empire, be a means of opening that vast tract of country to European influence and civilisation.

Rise of Indian Tea.

Considering the popularity of tea in Great Britain, it is not surprising that some of our own countrymen should have conceived the idea of growing tea in British dependencies, and

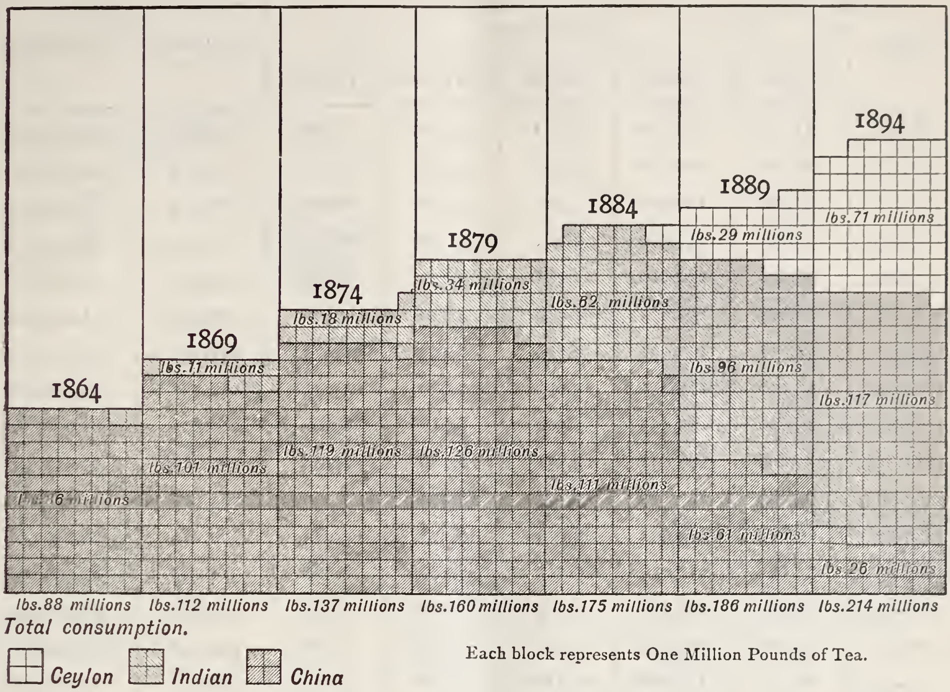
TABLE I.

SHOWING GRADUAL DISPLACEMENT OF CHINA TEA SINCE 1866, WITH PER-CENTAGE OF EACH KIND USED, AND QUANTITY OF ALL TEA PER HEAD OF POPULATION.

Year.	China, &c.	Per cent.	Indian.	Per cent.	Ceylon.	Per cent.	Total.	Quantity per head of population in lbs.
1866..	97,681,000	96	4,584,000	4	—	—	102,265,000	3·42
1867..	104,628,000	94	6,360,000	6	—	—	110,988,000	3·68
1868..	99,339,000	93	7,746,000	7	—	—	106,815,000	3·52
1869..	101,080,000	90	10,716,000	10	—	—	111,796,000	3·63
1870..	104,051,000	89	13,500,000	11	—	—	117,551,000	3·81
1871..	109,445,000	89	13,956,000	11	—	—	123,401,000	3·92
1872..	111,005,000	87	16,656,000	13	—	—	127,661,000	4·01
1873..	111,665,000	85	20,216,000	15	—	—	131,881,000	4·11
1874..	118,751,000	87	18,528,000	13	—	—	137,279,000	4·22
1875..	122,107,000	84	23,220,000	16	—	—	145,327,000	4·43
1876..	123,364,000	83	25,740,000	17	—	—	149,104,000	4·49
1877..	123,300,000	82	27,814,000	18	—	—	151,114,000	4·50
1878..	120,652,000	77	36,744,000	23	—	—	157,396,000	4·64
1879..	126,340,000	78	34,092,000	22	—	—	160,432,000	4·68
1880..	114,485,000	72	43,836,000	28	—	—	158,321,000	4·57
1881..	111,715,000	70	48,336,000	30	—	—	160,051,000	4·58
1882..	114,462,000	69	50,496,000	31	—	—	164,958,000	4·69
1883..	111,780,000	66	58,000,000	33	1,000,000	1	170,780,000	4·82
1884..	110,843,000	63	62,217,000	36	2,000,000	1	175,060,000	4·90
1885..	113,514,000	62	65,678,000	37	3,217,000	1	182,409,000	5·06
1886..	104,226,000	59	68,420,000	38	6,245,000	3	178,891,000	4·92
1887..	90,508,000	49	83,112,000	45	9,941,000	6	183,561,000	5·02
1888..	80,653,000	43	86,210,000	47	18,553,000	10	185,416,000	5·03
1889..	61,100,000	33	96,000,000	52	28,500,000	15	185,600,000	4·99
1890..	57,530,337	30	101,961,686	52	34,516,469	18	194,008,492	5·17
1891..	52,287,304	26	98,941,931	49	51,227,602	25	202,456,837	5·36
1892..	34,483,408	17	109,528,169	53	63,102,127	30	207,113,704	5·43
1893..	35,735,722	17	108,143,602	52	64,218,061	31	208,097,385	5·41
1894..	25,805,313	12	116,965,653	55	71,570,078	33	214,341,044	5·53

thus supplying the home demand from British-grown produce, instead of from the produce of a foreign power. There is strong ground for believing, and, indeed, it seems to be now an admitted fact, that tea is indigenous to India, and that it may have been conveyed from there to the Chinese Empire; in any case, it was found about the year 1819-21 in a wild state in the jungle of Assam; but so little weight was attached to this important discovery, that the Indian Government actually imported plants and native cultivators from China, to teach our countrymen in India how to grow and manufacture the imported product, China tea, actually ignoring the wild, indigenous plant growing on their own ground. Much harm has resulted to producers from the hybridisation of the China variety with the indigenous plant of Assam. But I do not propose to trace in detail the rise of the tea industry in India, from its birth to this hour. An admirable paper upon this subject was read here some few years since by a well-known tea-planter, Mr. J. Berry White. Let us, therefore, pass over the period of its early history, the trials through which it passed, after the speculative fever of about 1863, when the British public

Diagram I.—The decline of China Tea, and the rise of Indian and Ceylon Tea in the United Kingdom, shown by the quantity of each Tea used in each of the undermentioned years.



Each block represents One Million Pounds of Tea.

ran wildly into tea speculations, and imagined that a fortune lay in every new tea-planting venture, the unfortunate effects of which are still felt by many struggling tea companies, nearly strangled in their infancy by overloading of capital, and the consequent annually recurring difficulty of paying an adequate dividend upon a principal amount greatly in excess of the actual value of the property. Since that date several districts have been opened up at a much smaller cost per acre, and the money has been sent from Europe at a lower exchange. Increased facilities have been afforded by the introduction of suitable machinery, improved means of communication, and the greater general experience and consequent knowledge of the subject, together with concentration of labour, and a steadily falling exchange. In consequence of this, the dividend-earning powers of some of these later concerns were far greater in proportion to their capital, and they have thus been placed under greater advantages, and have given far more lucrative returns than many of the older companies.

The cost of production might be still further reduced if the Government could see their way to resume the old policy of giving grants in aid of local funds which are now rather starved.

From the small beginning which was made when, in 1834, the Indian Government caused plants to be obtained from China, and tried to open tea plantations in Kumaun and at Luckimpore, in the Province of Assam, where one of the first Indian tea plantations was started in 1835, the industry has spread slowly but surely, and, for the most part, profitably, until now not only Assam proper, or the Brahmaputra Valley, but Cachar and Sylhet, in the Surma Valley, Chittagong, East and Western Dooars, Terai, and Darjeeling, have become great tea-planting districts, while Chota-Nagpur and the districts of Kangra Valley, Kumaon, and Dehra Doon, celebrated for the Government plantations, where strong efforts to foster the industry were made in 1850, still continue to grow tea.

In Southern India, Neilgherry and Travancore have added their quota to the general production, the latter-named district being the most recent among all Indian tea-producing localities.

The total acreage under tea in India has increased until it has at present reached over 370,000 acres, and the yield in the present season is expected to be about 126,000,000 lbs.

TABLE II.

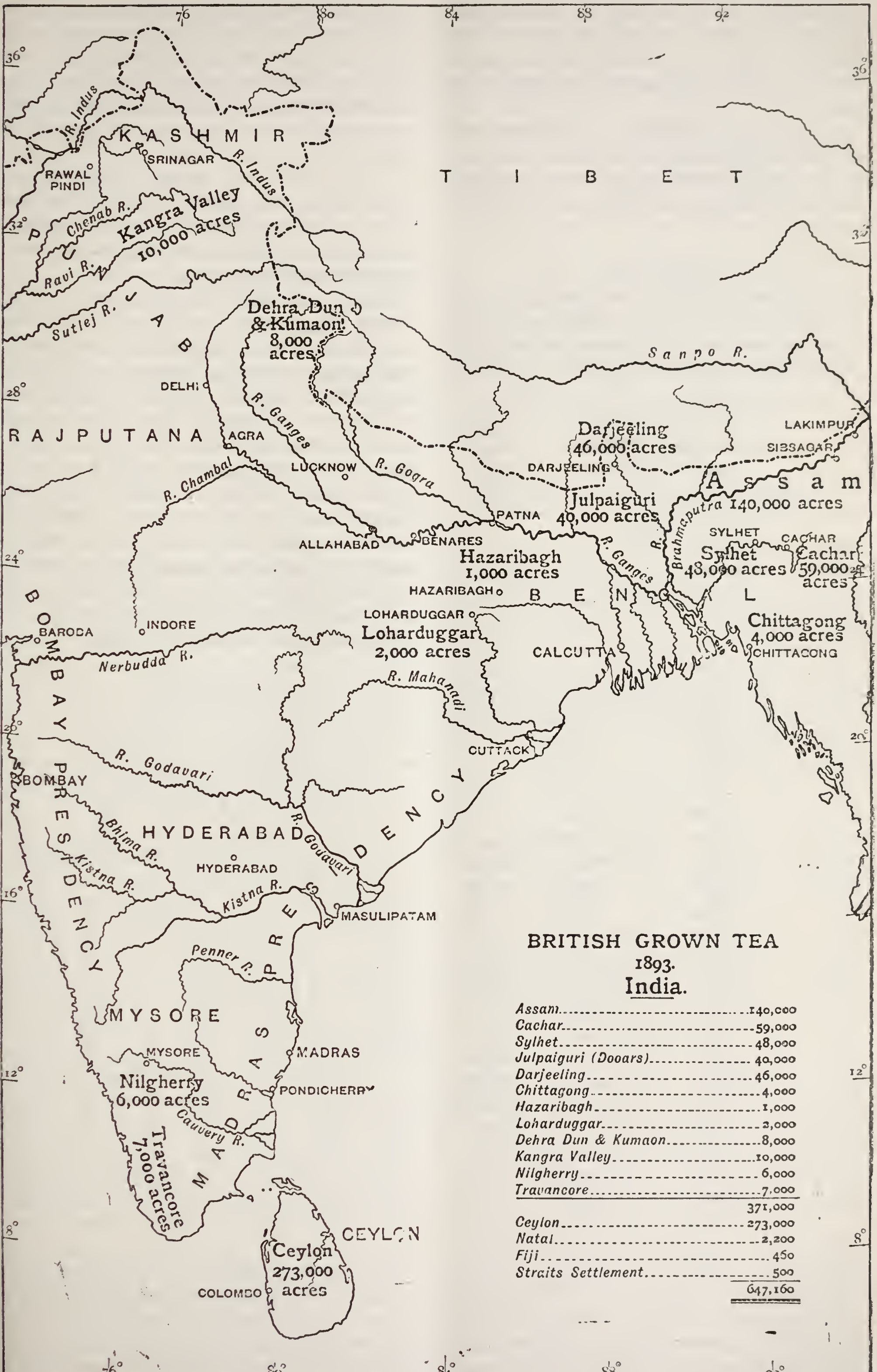
SHOWING THE APPROXIMATE ACREAGE UNDER TEA CULTIVATION IN INDIA FROM 1875-76 TO 1892-93, WITH THE ANNUAL YIELD IN LBS.

Season.	Area in Acres.					Total Area.	Yield in lbs.
	Bengal.	Assam.	Madras.	N.W. Provs.	Punjab.		
1875-76..	23,162	89,300	2,392	3,402	6,580	124,836	26,526,317
1876-77..	28,514	102,700	3,142	3,344	7,985	145,685	29,557,482
1877-78..	30,000	140,921	3,500	3,500	10,040	187,961	36,143,045
1878-79..	35,708	147,840	4,191	3,520	10,173	201,432	38,665,112
1879 80..	38,668	150,610	4,191	3,843	8 000	205,312	38,727,076
1880-81..	38,805	153,675	4,436	4,110	7,466	208,492	41,925,025
1881-82..	42,217	158,427	4,609	8,445	7,973	221,671	46,371,622
1882-83..	48,128	178,851	5,676	7,939	7,643	248,237	59,020,481
1883-84..	49 000	189,453	5,500	8,618	8,000	260,571	61,000,000
1884-85..	55,698	189,852	5,551	8,427	8,182	267,710	65,947,946
1885-86..	63,489	197,510	7,533	8,493	7,900	284,925	71,520,800
1886-87..	69,810	203,993	9,023	8,373	9,085	300,284	78,750,000
1887-88..	73,641	211,079	9,535	8,280	8,502	311,037	87,500,000
1888-89..	79,953	216,576	9,663	8,556	9,204	323,962	99,792,544
1889-90..	79,006	227,249	9,743	8,556	9,088	333,642	107,042,875
1890-91..	85,573	231,038	10,138	8,766	9,229	344,744	112,036,406
1891-92..	90,831	241,823	12,914	8,032	8,837	362,437	123,867,902
1892-93..	92,864	247,192	13,972	7,984	9,587	371,599	120,964,068

CEYLON TEA.

There is something pathetic about the rise of the Ceylon tea industry, for it rose as a Phœnix from the ashes of the ruined coffee plantations, which had brought golden harvests to the fortunate proprietors and were suddenly destroyed by the terrible ravages of the *Hemileia Vastatrix*, large tracts of coffee-bearing land covered with fruitful bushes being suddenly reduced in value from thousands of pounds to almost *nil*. The planters after trying cocoa, cinchona, cardamums, &c., with but partial success, finally turned their attention to tea. The extraordinary suitability of the tea plant for the climate compared with the coffee plant was strikingly illustrated by the fact that tea, when left untended, was found to force its way through the undergrowth and jungle, and to thrive and luxuriate in the midst of this tropical vegetation, triumphing alone and uncared for over the surrounding difficulties, while coffee untended was soon found to sicken and die. So much more suitable did the climate of Ceylon, with its abundant rainfall, prove for the leaf crop of the tea plant, than for the fruit crop of the coffee plant, that planters soon grasped the fact that, at last, they had found a product pre-eminently suited to the soil and climate of their island.

Hence, once tea was fairly started in cultivation, thousands of acres were quickly planted up, until in the course of a few years large tracts of land were covered with tea plantations, some 280,000 acres being under tea cultivation in 1894. So rapidly did the export increase that it rose from about 300 lbs. in 1876 to 81,000 lbs. in 1879, and 611,068 lbs. in 1882, and 4,352,895 lbs. in 1885, and about 84,000,000 lbs. in 1894; and the rise of the tea industry, which commenced when almost the whole island was in a state bordering upon ruin through the failure of the coffee industry, has resulted in the restoration of prosperity and comfort to the sorely-tried planters. Tea has indeed proved a blessing to them, and not only staved off the wolf from their door, but has again brought comfort and prosperity into their midst.



Walker & Boutall sc.

A Table is given showing the acreage and out-turn since the commencement of the industry, together with the average prices obtained in Mincing-lane for the crops each year.

A paper upon the Ceylon tea industry was read before the Society of Arts a few years ago by Mr. John Loudoun Shand, so I do not propose to go further into the history of Ceylon tea.

TABLE III.

Showing the Acreage under Tea Cultivation in Ceylon since 1867, and the Quantity Exported since 1873, with the Average Price obtained in the London Market since 1880.

	Cultivated acreage.	Exports in pounds.	Approximate average price.
1867	10	..	..
1868	200	..	..
1869	250	..	..
1870	..	..	..
1871	..	..	..
1872	260	..	..
1873	280	23	..
1874	350	492	..
1875	1,080	1,438	..
1876	1,750	757	..
1877	2,720	2,105	..
1878	4,700	19,607	..
1879	6,500	95,969	..
1880	9,274	162,575	10½d.
1881	13,500	348,157	11¾d.
1882	22,000	697,268	1s. 0¾d.
1883	32,000	1,665,768	1s. 3¼d.
1884	70,000	2,392,973	1s. 2¾d.
1885	102,000	4,372,722	1s. 3¼d.
1886	150,000	7,849,888	1s. 1¼d.
1887	170,000	13,834,057	1s. 1d.
1888	183,000	23,820,723	11½d.
1889	205,000	34,345,852	11¼d.
1890	220,000	45,799,519	11d.
1891	250,000	67,718,372	10d.
1892	262,000	72,279,985	9½d.
1893	273,000	84,750,000	9d.
1894 ..	about 280,000	about 84,000,000	8½d.

Present Condition of the Industry.

Having now traced very roughly and cursorily the progress of the tea industry to its present date, both at home and in India and Ceylon, let us consider the actual position as it now stands, both as to the consumption at home and as to the production in India and Ceylon, not omitting the vast resources of the Chinese Empire as a tea-growing country, and the smaller but still important tea industry of Japan.

In the early part of this paper we remarked upon the extraordinary fact that the United Kingdom consumed at the present time nearly as much tea annually as all other civilised countries combined.

Almost the entire quantity used in the United Kingdom is now Indian and Ceylon tea, China, as before-mentioned, having been at last almost driven out of the field. But the cost of the struggle has been tremendous, and has resulted in bringing down the average price of Indian and Ceylon tea from 1s. 5d., in 1881, when the quantity used was only 48,000,000 lbs., to 9¼d. in 1894, when the quantity used was 188,000,000 lbs. Even with this fall in price, room has been made for the produce of India and Ceylon only by turning out China tea, which, in the year 1894, had been displaced except about 26,000,000 lbs., as will be seen from the following Table :—

TABLE IV.

	Price, Indian Tea.	Price, Ceylon Tea.	Consumption, Indian.	Consumption, Ceylon.	Consumption, China Tea.	Total Consumption.
	s. d.	s. d.	million lbs.	million lbs.	million lbs.	million lbs.
1881......	1 5	0 11¾	48	(trifling)	112	160
1882.....	1 3	1 0¾	51	(trifling)	114	165
1883.....	1 2½	1 3¼	58	1	112	171
1884	1 1¾	1 2¾	62	2	111	175
1885......	1 2½	1 3¼	65	3	114	182
1886......	1 0	1 1¼	69	6	104	179
1887......	0 11½	1 1	83	10	91	184
1888	0 10¾	0 11½	86	18	81	185
1889......	0 10¼	0 11¼	96	29	61	186
1890......	0 10½	0 11	102	34	58	194
1891......	0 10¼	0 10	99	51	52	202
1892......	0 10	0 9½	110	63	34	207
1893......	0 9¼	0 9	108	64	36	208
1894......	0 9¼	0 8½	117	71	26	214

Now, as both India and Ceylon are continuing to increase their production, though not at so rapid a rate as in recent years, the problem which faces us is (1) if it has cost the planter 8d. per lb. to reduce to 26,000,000 lbs.

the annual consumption of China tea, from the figure at which it stood in 1881, viz., 112,000,000 lbs., what further sacrifice will be entailed upon him in displacing the remaining 26,000,000 lbs., and (2) when he shall have displaced this last figure of annual consumption, where is he to find a market for his still-increasing production?

Over-Production.—The natural answer to this problem seems at first sight to be; not to produce so much. But, when tea proprietors can be reckoned by hundreds, they cannot be prevented from opening up fresh land except by that bitter experience which comes from the disappearance of the margin of profit, and that experience must mean to them, and to a large part of the tea industry, nothing less than ruin.

The danger has long been foreseen, and, as the price has continued to fall, attempts have now and again been made to meet the danger by endeavouring to open up new markets. It would take too long to go into the details of the various schemes which have been inaugurated for forcing open new markets, and for educating the people of various lands to the merits of British-grown teas. It took a long time to establish a taste for Indian tea amongst the inhabitants of the British Isles, even though it was produced by our own countrymen, and we must not be surprised if the progress of British-grown tea be slow in countries which have to be weaned from a long established taste, and which would regard its production by our race as carrying with it no special recommendation. Still, such progress has been made in pushing our teas in foreign markets, that, with perseverance and redoubled effort, there can be no doubt of ultimate success. The importance of new markets cannot be over-estimated, for they seem the only means of combating the possible evil of over-production, or, in other words, of preventing the price from falling to that point where cultivation becomes unprofitable.

It is, therefore, with pleasure that one tells of the efforts which were made by both India and Ceylon, at the time of the Chicago Exhibition, to cultivate a taste for their teas in the important markets of the United States and Canada, which have an annual consumption of over 100,000,000 lbs. of tea. The sum of some £25,000 which Ceylon spent in the attempt, and the £7,000 which India disbursed cannot be considered as in any sense thrown away. These efforts are now being supplemented by still further subscriptions both from India and Ceylon, a voluntary contribution being raised in India, while the Ceylon colonists have agreed to the levying of a special tax by the Government upon the export of tea, in order to provide a fund for the opening up of new markets. India has, at the present moment, a Commissioner representing her in the United States, to promote the growth of a taste for her tea, while Ceylon is taking steps of a similar nature. Hence, in this so-important market of North America, there is the prospect of a taste for British-grown tea being gradually established. The following figures are encouraging; they show the quantity of Indian and Ceylon tea (in lbs.) exported from Great Britain to the United States and Canada during 1892 and 1893, both from bonded warehouses and under transhipment bonds:—

TABLE V.

To the United States of America.

	1892.	1893.
Indian Tea.		
From bonded warehouses....	600,216	818,356
Under transhipment bonds ..	121,958	352,961
Total lbs.	722,174	1,171,317
Ceylon Tea.		
From bonded warehouses....	710,365	705,567
Under transhipment bonds ..	47,974	212,788
Total lbs.	758,339	918,355

To Canada.

	1892.	1893.
Indian Tea.		
From bonded warehouses....	789,065	681,407
Under transhipment bonds ..	25,187	154,715
Total lbs.	814,252	836,120
Ceylon Tea.		
From bonded warehouses....	613,817	731,760
Under transhipment bonds ..	13,330	19,983
Total lbs.	627,147	751,743

Russia is also commencing to take a fair proportion of Ceylon tea. Persia and Turkey consume an appreciable amount of Indian tea, but of all the markets outside Great Britain the only one of any magnitude is Australasia, where some 14,000,000 lbs. of Indian and Ceylon tea are now annually used against only 7,000,000 lbs. four years since.

But the total consumption of Indian and Ceylon tea outside Great Britain is at present only about 30,000,000 lbs., an insignificant figure in comparison with the total production; still, abundant encouragement is to be derived from statistics which show that in 1890 the

quantity used was about 14,000,000 lbs., in 1891 about 20,000,000 lbs., in 1892 about 20,000,000 lbs., in 1893 about 25,000,000 lbs., and in 1894 about 30,000,000 lbs., so that the advance has been steady, and if the figures are not large they are none the less encouraging, as proving that a foothold has been gained for British grown tea in many of the most important markets of the world. There is no reason to anticipate a retrograde motion in this all important matter of increased consumption in foreign markets; but quite the contrary, for wherever a firm foothold has once been gained for Indian and Ceylon tea its inherent qualities have proved sufficient to ensure the continuance of its use.

Everything points to a marked and important expansion of this vital branch of the trade, the importance of which it is impossible to overrate, indeed, it would be a wise policy on the part of garden owners to spend some of their earnings in the opening of new markets instead of in the opening up of so much fresh land for cultivation.

The annual consumption of tea in the civilised world, exclusive of the United Kingdom, is about 250,000,000 lbs. Of this quantity only about 30,000,000 lbs. are Indian and Ceylon. How long will it be before the displacement of China tea here becomes as great as in the United Kingdom? It is this great foreign market that producers must now hope to conquer.

Such is the present position of the industry. The few million pounds annual increase in consumption in the United Kingdom is inadequate to take the whole of the probable increases from India and Ceylon in the near future. But there is hope, and great hope, that the efforts to open up new outlets will still meet with success, and in time obviate any fear of the catastrophe which has overtaken so many producing industries when production has run so far ahead of consumption as to cause a fall in prices sufficient to render the industry unprofitable. The tea industry has hitherto been exempt from such disaster, and with prudence, forethought, and persevering energy in the direction of opening up new markets there seems every probability of continued prosperity for the growers.

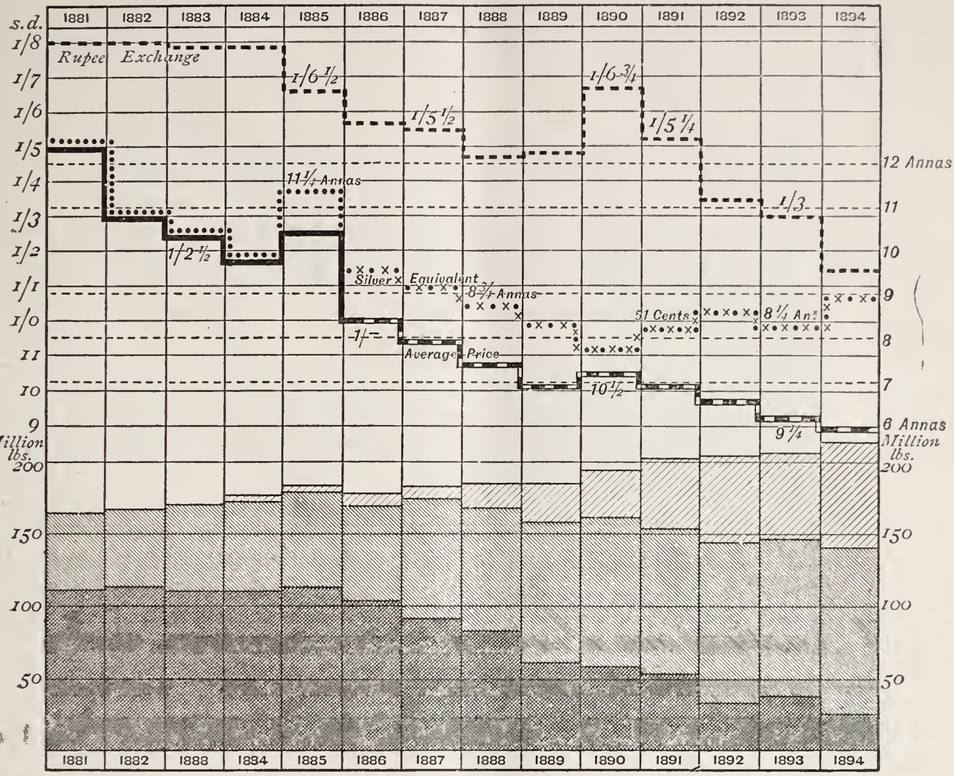
Silver.—It must not, however, be forgotten that one of the chief factors in the prosperity of the tea trade has been the continued fall in the price of silver. Tea is grown in countries with silver currency (with the exception of Java) and sold in Great Britain which has a gold currency, hence the proceeds of the sale, less the profits, are used in the purchase of silver, which has declined year by year in value as related to gold, and the proceeds are thus remitted to the country of production for upkeep of estates, labour, &c. (See diagram II., p. 199).

But the rupee has fallen so low that it is much nearer the cost of its production than when it stood at 2s., and there seems no reason to believe that it will fall much lower, the action of the Indian Government in closing the mints to silver having maintained the rupee at a value much above its intrinsic worth. The closing of the mints is of some importance to the tea enterprise, for it practically places a tax of nearly 1d. per lb. upon the production of Indian and Ceylon tea, as compared with the teas of China and Japan, where actual value regulates the price of the dollar. This tax may be of little importance to a country like England, where the trade in Indian and Ceylon tea has become thoroughly established; but it may seriously affect the prospects of these teas in countries such as the United States of America and Canada, where the industry, being in its infancy, price is a serious consideration, for China and Japan can furnish an abundant supply of very low-priced tea of a quality which has hitherto satisfied the American palate. Our hope is that, as the United States only consume annually about 1½ lbs. per head of population, and Canada about 4 lbs., while Great Britain takes 5½ and Australia nearly 8, the establishment of really good drinking tea in the continent of North America will lead to a considerably-increased consumption.

It is, at any rate, most gratifying to notice that in the last few years a marked increase in the use of British-grown tea occurred in Australia, as well as in the United States and Canada, and that there is every reason to believe that this increase will proceed continuously in these two important markets. The very large market of Russia, which was practically closed to all but China tea until a few years since, has of late shown signs of opening its doors freely to the teas of India and Ceylon.

Unless production be suddenly increased at an alarming rate, as did occur on one or two occasions during the past 10 or 15 years, there seems now no great occasion for anxiety in the near future on the part of our tea producer. He is fully alive to his dangers; and he knows that he has a large part of the civilised world still to conquer, and having already attacked, with considerable success, two large continents

Diagram II.—Showing the fall in the average price of British-grown Tea, and its increased consumption in Great Britain; also the decline in value of the Rupee, and the approximate return in Rupees to the Tea Planter at the various stages of exchange:—



Tea consumption. Ceylon Indian China

Average annual price of British-grown Tea.

Average annual value of the Rupee.

•x•x•x•x• Approximate equivalent of the London price in Rupees at the various rates of exchange, after allowing about 1½d. per lb. for charges, thus illustrating the benefit the Planter has received from the fall in exchange.

—North America and Australasia—he is confident that he can carry on his operations to final victory. He will doubtless remember that nearer home there is a field for his enterprise, for the main portion of the continent of Europe, which is still almost an unknown land to him, has shown signs of willingness to yield to well-directed efforts. The whole of South America is, also, as yet almost untouched, and may eventually prove ready to acknowledge the merits of Indian and Ceylon tea in preference, not only to other kinds of tea, but also to the beverage so largely used there, and generally known as "Paraguay Tea," although not belonging to the tea family at all. Perhaps, also, more determined efforts might be made by Indian planters to foster a taste for their teas among the 280,000,000 of our Indians subjects.

Table VI., page 199, shows the principal markets outside Great Britain, with the amount of tea used in various years past, together with the rates of duty at present levied upon tea.

NATIONAL IMPORTANCE OF TEA INDUSTRY.

The welfare of the tea industry is of very great importance to the nation, for the amount of British capital embarked in the enterprise is enormous, that in India probably reaching £15,000,000, and in Ceylon, £11,000,000, making a grand total of £26,000,000, and this sum is largely held by proprietors at home.

Besides this, as a field of enterprise and employment for the rising generation, the tea industry furnishes a most important outlet to

TABLE VI.—AVERAGE ANNUAL CONSUMPTION OF TEA IN ENGLISH POUNDS.

	1880-84.	Per head of Population.	1885-89.	Per head of Population.	1890.	1891.	1892.	Approximate duty in pence per English Pound.
Australia	18,200,000	7·66	21,488,920	7·66	21,253,186	23,262,413	24,009,091	Free to 6d.
New Zealand	3,902,000	7·23	4,337,453	7·19	3,849,105	4,103,190	3,703,716	6d.
Tasmania ...... (about)	699.500	5·35	907,035	6·37	977,864	931,207	1,099,188	3d.
Great Britain	170,733,600	4·70	183,153,080	4·91	193,949,452	202,396,631	207,055,679	4d.
Newfoundland	824,000	4·38	852,073	4·41	871,281	912,600	say 920,000	3d. + 20% ad. val.
Canada	16,600,000	3·69	18,849,450	3·90	18,455,475	17,990,630	22,718,181	10% from U.S.A., others free.
United States	71,175,314	1·20	79,173,100	1·34	83,494,956	82,395,924	89,610,741	Nil.
Holland	4,860,373	1·16	5,173,694	1·16	5,615,763	5,907,374	5,876,786	$2\frac{1}{4}$d.
Cape Colony	1,128,500	0·90	1,169,892	0·85	1,464,109	1,167,447	1,885.734	8d.
Natal	327,300	0·76	540,832	1·13	520,787	340,682	312,332	6d.
Russia	62,408,500	0·61	70,543,866	0·77	73,661,760	67,228,813	71,592,336	$2\frac{3}{4}$d. to 1s. $10\frac{1}{2}$d.
Denmark	733,800	0·37	798,306	0·37	752,957	860,782	912,815	4d.
Uruguay, 1884	176,930	0·34	203,419	0·29	174,855	126,835	171,745	About 2s.
Argentina, 1883-84	900,000	0·30	1,118,135	0·28	1,121,960	say 1,200,000	say 1,300,000	$5\frac{1}{2}$d.
Portugal	561,000	0·12	589,136	0·13	642,675	533,051	546,567	2s.
Switzerland, 1880-82	292,000	0·10	287,274	0·10	185,158	414,455	431,007	$1\frac{3}{4}$d.
Norway	170,400	0·09	183,082	0·10	196,548	189,169	212,224	1s.
Germany	3,113,500	0·07	3,975,882	0·08	4,595,340	5,018,508	5,668,688	$5\frac{1}{2}$d.
Morocco .... (about)	345,000	0·06	744,873	0·10	856,750	1,086,650	1,081,200	10% ad. val.
Belgium, 1883-84	155,896	0·03	135,379	0·02	127,135	131,169	137,158	$3\frac{3}{4}$d.
Sweden, 1880-83	139,250	0·03	198,796	0·04	259,196	282,819	say 290,000	3d.
France, 1882	1,029,561	0·03	1,168,317	0·03	1,355,663	1,351,587	1,452,173	$8\frac{3}{4}$d.-$11\frac{1}{2}$d.
Austria-Hungary, 1883-84	739,500	0·02	1,071,925	0·03	1,263,889	1,405,352	1,594,703	$9\frac{3}{4}$d.-$10\frac{3}{4}$d.
Bulgaria, 1884	33,669	0·02	63,008	0·02	123,332	108,345	144,344	$8\frac{1}{2}$% ad. val.
Spain, 1884	136.000	0·01	224,720	0·01	201,101	168,971	136,077	1s. 2d.
Total of all Tea	359,385,593		396,951,647		415,970,297	419,514,604	442,862,485	
British Grown	53,000,000		94,000,000		150,000,000	170,000,000	193,000,000	
China, &c.	306,385.593		302 951,647		265,970,297	249,514,604	249,862,485	

the mother country. There are, perhaps, few amongst us who have not friends or relatives working under a tropical sun in the tea districts, thus imparting to most of us a personal interest in the welfare of this great industry.

The hundreds of thousands of natives in our Eastern dependencies who derive their livelihood from it marks another feature in which its welfare assumes a national character, the native labourers employed in India and Ceylon together aggregating about one million people, besides the children who have to be provided for by these labourers and actually dwell upon the tea estates.

If we were to add to these the numbers who earn their livelihood through its instrumentality in this country by the manufacture of machinery, and the export of various necessaries, as well as those distributing tea in Australasia, the Imperial character of its welfare would be still more noticeable, and would show even more forcibly the debt of gratitude the nation owes to those who first proved the practicability of cultivating the tea plant in India and Ceylon.

Considering the amount of capital embarked in tea cultivation, it is, perhaps, strange that so little pecuniary interest in the various producing companies has hitherto been held by the general public. This is probably most easily accounted for by the fact of very few of the shares being quoted on the London Stock Exchange, and the consequent fear that they should not prove easily marketable. But during recent years this difficulty has to a great extent been overcome, and at the present moment securities of this kind are dealt in with considerable ease, a fair price being now almost always obtainable for good tea companies' shares, while there are strong reasons for believing that still greater facilities will be forthcoming in the near future; so that tea securities appear likely to become as readily marketable as many other shares.

At a time when the difficulty of obtaining more than an extremely small rate of interest on capital is felt by the public as keenly as it is at the present moment, there certainly appear to be many inducements for more general investment in tea-producing concerns. By many of these a very good annual return is obtainable at the present market value of the shares, while several have large accumulated reserve funds for equalisation of dividends, added to which the security offered by the possession of actual landed property, with buildings, machinery, and crops, should tend to draw the attention of the public more forcibly than hitherto to this class of investment.

From an imperial point of view, the greater the pecuniary interest the public hold in so far-reaching an industry, the more benefit is the Empire likely to derive from it; for, while it is the natural wish and expectation of British tea growers that the mother country will support their efforts to the fullest extent, still there is nothing like pecuniary interest to induce a desire for the well-being of an industry. The greater this interest is, the more is British grown tea likely not only to be consumed by our fellow-countrymen at home but to be asked for and demanded in foreign countries. The public thus become instrumental in that most important office of assisting in the opening up of new markets. And a commercial bond is formed between the mother country and her possessions—which strengthened by ties of relationship, as well as by the knowledge that almost 90 per cent. of the tea we use is now grown in our own dependencies, should tend more and more to increase that much needed feeling of unity between Great Britain and her Colonies, which is the desire of all who wish for the continued prosperity of the British Empire.

Table showing the Area under Cultivation of Tea in Natal from 1880 to 1893.

Year.	Acres in Cultivation.	Year.	Acres in Cultivation.
1880	8	1888	801
1883	149	1889	1,090
1885	340	1890-91	1,765
1886	410	1891-92	1,673
1887	576	1892-93	2,200

Table showing the Area under Cultivation of Tea in Fiji from 1888 to 1893.

1888	325	1891	250
1889	*Nil*	1892	456
1890	*Nil*	1893	460

DISCUSSION.

Sir Henry Peek, Bart., said this was a most admirable paper, and contained most valuable statistics. There were two matters to which he should like to call attention, the first being the decay of the China trade and the rise of the Ceylon and Indian trade; and though they were all pleased to find that the products of our own dependencies were taking the

place of those of foreign countries, he could not help thinking that a great mistake had been made both in India and Ceylon. The way in which tea was produced in China was certainly better than that followed in our own dependencies. He did not refer to the use of machinery, which was no doubt an advantage, but to the process which left so much tannin in the tea. He had in his hand the prize essay by Colonel Money on tea cultivation, which he believed won a large premium, and in that essay the author distinctly stated that the tannin should not be thrown away. He said that in a certain stage of the process the mass of tea leaves gave out juice freely, none of which should be lost, but should be mopped up into the roll again and again. This explained in a great measure what was called the superior strength of the Indian and Ceylon tea compared to that from China, and it was this which gave the large proportion of tannin, which Sir Andrew Clarke and other physicians distinctly said was so injurious to many people. Not long ago, a gentleman came to him and said he had a daughter very ill, and that the doctor had ordered her by no means to drink any but China tea, the tea with the tannin left out; and, of course, he was very pleased to furnish him with a supply. He could not help thinking that if the present system were continued the Indian and Ceylon trade would suffer in the long run. With regard to what was called the free breakfast-table, he thought it would be a great mistake to remove the tea duty altogether. In 1863, when the duty was 1s. a pound, Mr. Gladstone said, in his opinion, it would be unwise to lower it; and he thought the great art of taxation was that everybody should bear their fair share. Now, if a working man were a non-smoking teetotaller, he paid next to nothing, and on that ground he was opposed to doing away with the very moderate duty of 4d. a lb., which nobody really felt, and which brought in a large sum. In 1893 it produced £3,499,000, so that it would provide the country with four new ships of war every year. The consumption of tea had not risen very much within the last few years, only half a pound per head.

Mr. GEORGE SETON thought those best acquainted with the matter would agree that the question of tannin was not one which ought to be despised, and he was glad Sir Henry Peek had raised it, but he believed it must be dealt with not by the planter, but by the consumer in preparing the tea. It was quite true that in Indian and Ceylon tea there was more tannin than in Chinese, and that was why a smaller quantity went as far, but that ought to be recognised and dealt with accordingly. The tea was quite good and wholesome if it were properly prepared, and not allowed to stand too long.

Mr. T. CHRISTY said it was well known to those who had studied the chemistry of tea that the tannin was in the lower leaves and stems, so that it was entirely a question of money. The nearer you went to the top of the plant the less tannin, and the higher the price the tea fetched, and with good reason. In these top leaves and shoots was found the caffeine, which was really what people took tea for. Mr. Stanton spoke of "fulness," but he did not mean the tannin, but the comfort obtained from a cup of tea in consequence of the caffeine. You could obtain no crystallisable alkaloid from the coca plant grown in Java; but in Brazil you got a leaf which gave the alkaloid now so much used as an anæsthetic. In the same way you could get no caffeine from Java tea nor in that from Japan, or hardly any. Then coming to China tea, he maintained that the reason why it had gone out was not because of any peculiarity in the make, but because it had not the caffeine in it which the consumer so much desired; there was only 1 per cent. The Ceylon tea was very fine and had a beautiful flavour, such as you used to get in China tea; but when you came to India, you got from 3 to 3½ per cent. of caffeine; and up in Assam, the natural habitat of the plant, it was the richest of all in caffeine. Last year there was no less than 5,000 lbs. of caffeine sent to America, because the Americans knew its value, and they carried little pilules or cachets of caffeine to take of an afternoon, because the tea they drank did not afford it. That caffeine was made from tea which came to London, and if the Americans had drunk Ceylon or Assam tea, they would find they got the caffeine they wanted. Books on chemistry stated that the utmost amount of caffeine found in tea was 4 per cent.; but within the last few months he had found over 6 per cent. in Assam tea. It was not found in the lower part of the leaf, but in the upper part and the fine shoots; and when people paid fabulous prices for the points of the tea plant they were really quite right, because that was the best part. This was the sort of tea the Russians bought; they did not buy the low qualities of China tea. Last year 400 tons of tea were turned into caffeine, and whereas it sold originally at 8s. lb., so great was the demand, that it went up to 20s. in December. It was highly appreciated in America; and no matter what price it was they would have it. He believed, therefore, that as soon as they found out the value of Indian and Ceylon teas, they would be only too glad to have it.

Mr. PYE said he should like to ask a question about the keeping qualities of tea. They knew that a sample of Ceylon tea was not worth much at the end of six months, and Indian tea would not keep well for twelve months. but China tea would certainly keep longer than either. Another point in connection with China tea which had not been mentioned was the export duty. That was on some qualities at least 10 per cent., and the inland duty another 10 per cent. With the incidents now

taking place in China, the whole situation might be changed, and if the first cost were reduced 20 per cent., China tea might yet be a very formidable competitor.

Mr. F. S. HAWES suggested that the reason why Ceylon tea did not keep so well was because it was grown in a damp climate; it had nothing to do with the mode of manufacture.

Mr. ERNEST TYE thought Mr. Stanton had not dealt sufficiently with the different varieties of tea grown in different parts of India. The Sylhet teas differed from those of Assam, and those again from the teas of Darjeeling, which were of a particularly fine character, far above those produced anywhere else. The teas from some parts of Ceylon bore some resemblance to the Darjeeling tea on the lower altitudes, but, on the whole, no tea yet grown equalled the best Darjeeling. He hoped that in time the English public would learn to distinguish the teas from the different districts, and recognise their merits, as they did tonics, and even to know the names of particular tea-gardens, and the brands. He did not think the ordinary public knew much about the tannin question, but the difficulty would be entirely overcome if they would only learn to make tea in one pot and then pour it into another, and not let it stand too long upon the leaves. If Sir Andrew Clarke had had his tea properly made, he would never have raised the cry about tannin.

Mr. CHRISTISON said he had been engaged in the cultivation of tea for thirty years. With regard to the keeping qualities, he thought it largely depended on the treatment the tea received in the London warehouses; the boxes were broken open and left for months sometimes, with no attempt to preserve them from the air. He had kept Indian tea for seven, eight, and ten years, and it improved by keeping, if it were hermetically sealed. Tea was peculiarly susceptible to moisture, and if left open of course rapidly deteriorated. He was one of the judges of the essays referred to by Sir Henry Peek: the competition took place in 1862, it was not a very large prize, and he thought too much importance had been attached to the essay, which at any rate was now quite out of date. He did not think the process referred to had any thing to do with the tannin. It was keeping the tea infused too long which brought out the tannin.

Mr. WM. MACKENZIE said the book referred to by Sir Henry Peek was twenty-five years old; at that time machinery had not been introduced into India, and no tea at all was grown in Ceylon, so that the author's remarks could not be held accountable for any supposed defects in the quality. It was proverbial again that doctors differed in opinion. China tea was kept a long time because it was not used, but Ceylon tea went off so rapidly that there was no occasion to keep it. When there was a constant supply of freshly-grown tea, they did not want stuff which had been kept several years. If they wanted it to keep, they would make it differently, but then it would not be welcomed in every household as it was now. They evidently made tea in Ceylon which suited the public taste, or there would not be such a demand for it, and he hoped before long that it would take the same hold of other countries.

Mr. WALTER REID asked if Mr. Stanton could throw any light on the question, what kind of beverages the increased consumption of tea was displacing—coffee and cocoa, or alcoholic drinks? With regard to future competition in the tea trade, there were several countries which might at no distant date produce tea; for instance, certain parts of Brazil were well suited for the cultivation, if there were a good supply of labour, and possibly Australia, which was now a large consumer, might some day produce her own, and even export it. The question of tannin was certainly one of importance; not only Sir A. Clarke, but a large number of the medical profession were of opinion that there was considerable danger from an abuse of tea. If you put a beverage into the hands of the masses, you could not limit the quantity they would drink, and the result was that the tannin acted injuriously on the digestive organs. There were two ways of getting rid of tannin: one was, to pick out only delicate leaves, which would be more expensive, but which were certainly better, and contained very little tannin; and the other was either in the process of manufacture to extract the tannin without extracting the theine, or to add something which would render the tannin innocuous; for he was afraid they would never be able to get everyone to treat tea properly in the preparation of the beverage. The theine was what Mr. Christy called the caffeine, but he preferred the old name, because there was some doubt whether it was really the same substance as caffeine. There was a large opening for the preparation of this article. Why should the planters of Assam send the leaves over here for us to extract the theine, and then throw the leaves away, when they might prepare it on the spot, and send it direct to America, or even to England, where, no doubt, there were many also who would like to be able to carry a cup of tea about with them. It must be remembered that theine was volatile; and it was quite possible that the proportion found in the leaves when offered to the consumer might depend, in some measure, on the mode of preparation.

Mr. JOHN HUGHES said he might read a few figures which he had recently obtained, as so much had been said about tannin. He took three kinds of tea, Assam, Ceylon, and China, and found the per-centage of tannin present to be as follows:—

	After 5 min. infusion.	After 30 min.
Assam	10·35	14·76
Ceylon	8·60	10·88
China	7·80	9·40

The difference, therefore, was very small indeed between China and Ceylon, and would hardly be noticed. It depended a great deal on how the tea was made, and he was surprised that Mr. Stanton had not given some directions on that point. He would also recommend people to ask their grocers to supply them with either India, Ceylon, or China tea, and not with mixtures, such as he was sorry to say seemed to be getting very general. He did not think the increase in the consumption of Ceylon tea was so much due to the taste of the public as to the operations of certain gentlemen in London, who found it to their interest in preparing their "blends" to use Ceylon tea. He had visited Ceylon on two or three occasions, and on behalf of the tea planters he asked that the teas they sent over should be judged on their own merits, and nothing would do more to recommend them than to use them pure and simple rather than in a blend.

The CHAIRMAN said he thought Sir Henry Peek was mistaken in his explanation of the strength of Assam tea; the real explanation was that it was manufactured within a few hours of being gathered. China tea was produced by small farmers who, when they had gathered the leaves, had to take them, six, eight, or perhaps fifteen miles, before they were manufactured, and as the tea was grown in a hot, damp climate, a considerable amount of fermentation set up in the course of a very few hours, and detracted from the strength, since the most valuable portion, the volatile caffeine, was lost. Then the Assam tea was an altogether different species from the Chinese tea. Many years ago the Government of India went to immense expense in importing Chinese tea plants, and for many years they were spread over Assam; then it was found accidentally that there was a species of tea growing in the jungle, which at first was thought to be unfit for use, but an enterprising Englishman manufactured some of the leaves and sent them over, when the experts in Mincing-lane pronounced it the finest tea ever sent to London. This plant was gradually developed, and for many years it was cultivated under great difficulties, for whenever it was in proximity to the Chinese plant the latter hybridised it, with very injurious effects. The indigenous plant produced a tea of higher strength and quality, more rich in caffeine, than the China, and a far larger quantity of leaf per acre. Consequently, for the last 25 years, there had been a struggle on the part of the planters to eradicate the China plants, which had been imported at such expense. It was a mistake to suppose that the tea plant was introduced into China from Assam, because it was quite a distinct species. In Assam, tea was manufactured on a large scale; 500 acres was considered about the minimum extent for a garden; there was extensive machinery, and the plant was manufactured into tea within eight or ten hours after it was gathered. Very often tramways were laid down in order to facilitate the transport of the leaves to the factory, and of course nothing of this kind could be done by the small Chinese cultivators. He thought there was very little fear of competition from either Brazil or Australia. The tea plant required for its proper cultivation an extremely damp climate. In that part of Assam which produced the finest tea in the world, the rainfall was about 160 inches in the year, and in addition to a heavy rainfall and a high temperature, you wanted a large supply of cheap labour. This combination was certainly not to be found in Australia, and he doubted if it would be found in any part of Brazil. The evidence produced by Mr. Hughes on the tannin question was pretty conclusive; the difference was comparatively small, and no more than would be accounted for by the richness of the Assam tea in extractive matter generally. But he really thought this tannin question was, to a great extent, a mere bugbear; and that if a thoroughly scientific analysis were made, it would be found there was nothing in it. All he could say was that on a long march, and where troops were exposed to great hardships, a cup of Assam tea was one of the most sustaining and invigorating beverages a soldier could have. The advantages which the tea industry had conferred on the Indian Empire could hardly be exaggerated. Forty years ago the province of Assam was a wilderness covered with jungle and swamp, the abode of the tiger and wild animals of all kinds, but now it had become the home of an industrious peasantry. The districts of Bengal which supplied labour to Assam were extremely over-populated, and the people were sunk in poverty, but in Assam they found well remunerated labour, and were rapidly converting the country into a garden. The revenue had been doubled or trebled within the last ten years, entirely owing to the tea industry. Though there might be difficulties from over-production, he believed there was still great room for improvement, and if the Government would only complete the railway and steam communication with Bengal, they would be able to meet any difficulties that might arise from a fall in price.

Mr. STANTON, in reply, said that most of the points raised had been already dealt with by other speakers or by the Chairman. He was glad to hear Sir Henry Peek's remarks with reference to the tea duty, and thought it would be a great pity if it were taken off; for it was so moderate that even the poorest could hardly feel it. He could quite endorse what had been said as to tea not standing more than three or four minutes, and it would be a great advantage if, after standing a few minutes, it were poured off into another pot. When it was allowed to stew a long time all the extractive matter was brought out, including the tannin, which was better left in. What you wanted was flavour, and caffeine, which, more than anything else, constituted tea a real food. With regard to keeping qualities, he thought the London warehouses had

been rather hardly dealt with. It was absolutely necessary that the chests should be opened, and in a country like this it was impossible to close them up again perfectly air-tight. Nowadays, tea was not grown or made with the intention of keeping, because there was no need, nor even opportunity, for it; it was sold too fast. With regard to the displacement of other beverages, some five or six years ago Mr. Goschen published a table which showed that a very large increase had taken place in the consumption of certain non-alcoholic beverages, whilst the alcoholic had remained almost stationary, or had increased to a very much less extent. With regard to the production of tea in Australia and Brazil, he need not add to what the Chairman had said.

The CHAIRMAN then proposed a hearty vote of thanks to Mr. Stanton, which was carried unanimously, and the meeting adjourned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

JANUARY 30.—"Peking." By THOMAS CHILD PROFESSOR ROBERT K. DOUGLAS will preside.

FEBRUARY 6.—"The Labour Question in the Colonies and Foreign Countries." By GEOFFREY DRAGE. The DUKE of DEVONSHIRE, K.G., will preside.

FEBRUARY 13.—"Light Railways." By W. M. ACWORTH. SIR BENJAMIN BAKER, K.C.M.G., F.R.S., will preside.

FEBRUARY 20.—"Rule of the Road at Sea." By ADMIRAL P. H. COLOMB.

Papers the dates of which are not fixed:—

"The Use of Aluminium in the Separation of Metals from their Oxides." By PROFESSOR WILLIAM CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. CHARLETON, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. CROMPTON, M.I.E.E.

"Electric Lighting of Ecclesiastical Buildings." By MAJOR-GENERAL CHARLES E. WEBBER, C.B.

"Our Food Supply from Australasia." By E. MONTAGUE NELSON.

"Cider." By C. W. RADCLIFFE COOKE, M.P.

"Improvements in Milling Machinery." By J. HARRISON CARTER.

"Sand Blast Processes." By JOHN J. HOLTZAPFFEL.

"Modern Photogravure Methods." By HORACE WILMER.

AFTERNOON LECTURE.

THURSDAY, MARCH 14, AT HALF-PAST FOUR.—"Art Tuition." By PROF. HUBERT HERKOMER, R.A.

INDIAN SECTION.

Thursday Afternoons, at Half-past Four o'clock:—

JANUARY 31.—"India and its Women." By S. E. J. CLARKE, of Calcutta. (The paper will be read by SIR ALEXANDER WILSON.)

FEBRUARY 14.—"Village Communities in Southern India." By C. KRISHNA MENON, Lecturer on Agriculture at the Sydapet College, Madras. SIR CHARLES ARTHUR TURNER, K.C.I.E., will preside.

MARCH 28.—"Chitral and the States of the Hindu Kush." By CAPT. F. E. YOUNGHUSBAND, C.I.E.

APRIL 25.—"The Coming Railways of India, and their Prospects." By J. W. PARRY, A.M.Inst.C.E., late Executive Engineer Indian State Railways.

MAY 23.—"Punjab Irrigation: Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

The meetings of March 28, April 25, and May 23 will be held at the Society of Arts; those of January 31 and February 14 at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 19.—"Paraguay." By A. F. BAILLIE, Consul in London for Paraguay. LIEUT.-GENERAL SIR ANDREW CLARKE, G.C.M.G., C.B., will preside.

MARCH 5.—"Colonies and Treaties." By SIR CHARLES M. KENNEDY, K.C.M.G., C.B.

APRIL 2.—"Commercial Education in Belgium." By PROFESSOR WILLIAM LAYTON.

APRIL 30.—"Madagascar." By CAPTAIN S. PASFIELD OLIVER.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

FEBRUARY 5.—"Drawing for Process Reproduction." By GLEESON WHITE. LEWIS FOREMAN DAY will preside.

FEBRUARY 26.—"Mediæval Embroidery." By MRS. MAY MORRIS SPARLING.

MARCH 19.—"Carpet Designing." By ALEXANDER MILLAR. J. HUNGERFORD POLLEN will preside.

APRIL 23.—"Art of Casting Bronze and Copper in Japan." By WILLIAM GOWLAND. PROF. W. C. ROBERTS-AUSTEN, C.B., F.R.S., will preside.

MAY 7.—"Recent Improvements in Designing, Colouring, and Manufacture of British Silk." By THOMAS WARDLE.

MAY 28.—"The Decoration of St. Paul's." By PROF. W. B. RICHMOND, A.R.A.

CANTOR LECTURES.

PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S., "The Arc Light." Three Lectures.

JANUARY 28, AT 8 O'CLOCK.—LECTURE III.—Arc-lamp mechanism—The requirements to be met, and methods of fulfilling them—Alternate current lamps—Special lamps—Qualities of carbons—Accessories.

ALAN S. COLE, "Means for verifying Ancient Embroideries and Laces." Three Lectures.

FEBRUARY 11.—LECTURE I.—Sources from which may be taken indications of ornament in textiles ascribed to Egyptians, Assyrians, and other kindred Oriental people—Actual embroideries from 1000 B.C.—Distinction between embroideries and weavings—Three broad classes of embroidery, and the antiquity of them—Climate as affecting the use of materials—Linen and wool chiefly used by Egyptians, Assyrians, and Greeks—The darning or inweaving method of embroidery predominant with them—Its development later as a weaving process—Gold thread employed with coloured threads in the darning embroideries—Examples of ornamented textiles from early Egyptian paintings—Patchwork a notable method with Egyptians and Assyrians—Examples of Assyrian and Persian embroideries.

FEBRUARY 18.—LECTURE II.—Types of Assyrian and Greek textile ornaments compared—Homer's references to ornamental textiles—Grecian women and embroidery—Lighter kinds of embroidery produced by Greeks than by Egyptians, Assyrians, and Persians—Examples of textile ornaments taken from Greek vases of Sixth Century B.C. ornament—Varieties of embroideries taken from Græco-Scythic tombs of Third and Fourth Centuries B.C.—Fresh varieties of ornament displayed in actual specimens of Egypto-Greek and Roman-Saracenic work—Saracenic Byzantine specimens (about Eighth or Ninth Century A.D.) of silk and linen work—Early Christian emblems in embroideries.

FEBRUARY 25.—LECTURE III.—Lace—Its development from twisting, plaiting, and looping threads together into ornament—Early instances of simple nets for useful purposes only (Assyrian and Egypto-Roman)—Absence of suggestions of lace until about Sixteenth Century A.D.—Gradual changes in the texture and dimensions of laces—Specimens of the different sorts compared with laces for flounces, &c., indicated in portraits.

⁂ Mr. Cole's lectures will be delivered in the afternoon, at Four o'clock.

DR. D. MORRIS, C.M.G., "Commercial Fibres." Three Lectures.

March 18, 25, April 1.

JAMES DOUGLAS, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures.

April 22, 29, May 6, 13.

ERNEST HART, D.C.L., "Japanese Art Industries." Two Lectures.

May, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Silvanus P. Thompson, "The Arc Light." (Lecture III.)

Scottish Society of Arts, 117, George street, Edinburgh, 8 p.m. Mr. William Fairley, "Filter Press Machinery for Sewage Disposal Works."

Imperial Institute, South Kensington, S.W., 8½ p.m. Lieut.-Colonel C. M. Watson, "Egypt and the Nile."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. H. Warington Smyth, "Journeys in South-Western Siam."

British Architects, 9, Conduit-street, W., 8 p.m.

Actuaries, Staples-inn-hall, Holborn, 7 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. R. W. Fraser, "Native Life in India."

TUESDAY, JAN. 29 ... Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The Internal Framework of Plants and Animals." (Lecture III.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. Annual Meeting.

WEDNESDAY, JAN. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Thomas Child, "Peking."

Photographic Club, Anderton's Hotel, Fleet-street, E.C. Messrs. Bridge and Bridgman, "Norway."

THURSDAY, JAN. 31 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. S. E. J. Clarke, "India and its Women." This Meeting will be held at the Imperial Institute, South Kensington.

Royal, Burlington-house, W., 4½ p.m.

Mechanical Engineers, 25, Gt. George-street, S.W., 7½ p.m. Professor W. Cawthorne Unwin, "The Determination of the Dryness of Steam."

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Ernest Pauer, "Franz Schubert."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. S. Lilly, "Four English Humorists of the Nineteenth Century." (Lecture III.)

Civil and Mechanical Engineers, 12, Delahay-street, Westminster, S.W., 7 p.m. Mr. W. M. Binney, "Engine-room Practice at Sea."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Cyril Davenport, "Decorative Bookbinding."

FRIDAY, FEB. 1 ... Royal Institution, Albemarle-street, W., 3 p.m. Mr. Henry Irving, "Acting—an Art."

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Captain H. Riall Sankey, "Comparison between Governing by Throttling and by Variable Expansion."

Geologists' Association, University College, W.C. 7½ p.m. Annual Meeting.

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, FEB. 2 ... Royal Institution, Albemarle-street, W., 3 p.m. Mr. Lewis F. Day, "Stained Glass Windows and Painted Glass." (Lecture III.)

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No. 2,202. Vol. XLIII.

FRIDAY, FEBRUARY 1, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

The third and last lecture of the course on "The Arc Light," was delivered by Professor Silvanus P. Thompson, D.Sc., F.R.S., on Monday evening, 28th inst.

The Chairman (Mr. Francis Cobb) moved a vote of thanks to the lecturer for his valuable course of lectures, which was carried unanimously.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

EIGHTH ORDINARY MEETING.

Wednesday, January 30, 1895; Professor Robert K. Douglas, in the chair.

The following candidates were proposed for election as members of the Society:—

Murphy, A. J., The Laboratory, 5, Carnaby-street, Leeds.

Pogson, Alfred Lee, Harbour Works Office, Madras.

Smith, Harold, Ingleside, Kenley, Surrey.

Struber, Frederick Pine Theophilus, Malpas-lodge, Torquay, Devon.

The following candidates were balloted for and duly elected members of the Society:—

Abbott, George Herbert, 115, Portland-street, Southport.

Becks, George Arthur, The Broadway Testing Works, Westminster, S.W.

Browne, Robert Jamieson, Howrah Dock, Howrah, Calcutta.

Clarke, Charles Henry, LL.D., 2, Rutland-terrace, High-road, Leyton, Essex.

Emerson, P. H., B.A., M.B. (Cantab), Claringbold, Broadstairs, Kent.

Hampton, George, 8, Pall-mall East, S.W., and 1, Cockspur-street, S.W.

Hayashi, Gonsuké, Japanese Consulate, 84, Bishopsgate-street Within, E.C.

Heath, Commendatore Henry Burnley, 31, Old Jewry, E.C.

Hirst, William, 9, Gracechurch-street, E.C.

Hopekirk, Walter, Crystal Palace, Upper Norwood S.E.

Knighton, William, LL.D., Tileworth, St. Leonards-on-Sea.

Langsford, John, 12, Soho-square, W.

Lawson, Archibald, Baker-street, Weybridge, Surrey.

Lewis, T. Lawrence, Local Board of Health, St. George, near Bristol.

Mathewson, Jeremiah Eugene, Tilghman's Patent Sand Blast Company, Bellefield Works, Sheffield.

Meath, Earl of, 83, Lancaster-gate, W., and Killruddery, Bray, Co. Wicklow.

Messer, Frederick Alfred, 8, Quality-court, Chancery-lane, W.C.

Pell, Bennett, 6, Granville-park, Blackheath, S.E.

Saunders, Ernest William, 19, Vicar-lane, Leeds.

Winmill, Hallett, care of Charles C. Winmill, Main-road, Bexley-heath, and Barberton, South Africa.

The paper read was—

PEKING.

By Thomas Child.

As the city of Peking is now prominently before the public, it has been suggested that it would interest you if I, who have lived there for twenty years, read a paper on that subject. The name of the place should be spelt with a "g" at the end, though it is known in England as Pekin. The Chinese spell it with two characters, one meaning the North and the other meaning Capital:—thus, the two characters, Pei-ching, mean the North Capital, which it is.

On the map of the world, England is on the west side of Europe, and Peking, the capital of China, nearly opposite on the east side of Asia. The sun, moving as he does at the rate of about a thousand miles an hour, takes nearly nine hours to complete his journey from Peking to England, so that it must be about 9,000 miles distant. There is actually a difference of eight hours forty-five minutes in the time, that is to say, eight o'clock here this evening is a quarter to five to-morrow in Peking.

Instead of abruptly dropping you down in Peking, I think it would be better were we to start from Tientsin, the Port of Peking, or even to go to the mouth of the River Pei-Ho, and start from Taku on the right bank of the river. It is the place where the British

gun-boats were destroyed in 1859. The sea is very shallow here, and for miles out at low water are banks of mud. The gun-boats stuck in the mud, and the Chinese peppered them to their hearts' content. Of course, they claimed a victory. The British next year attacked the forts from the land side, and as they entered at one door the Chinese passed out at another, which saved a deal of trouble. Since then the forts have been made impregnable by German engineers; but "as stone walls do not a prison make," neither do they make an impregnable fortress without strong arms and stout hearts to defend them. Nature has done more for the protection of the mouth of the river than man. The river brings down an immense quantity of clayey matter in suspension, and deposits it across the mouth in the form of a bar that has only a few feet of water upon it except in one place, and even here only vessels of light draught can get over at certain states of the tide. Taku, except the forts, consists of a few mud houses; it has come into fame lately on account of the naval dockyard that has been established here under the direction of Englishmen. On the opposite bank of the river is Tong-Ku. This is quite a modern place, made by the Colliery Railway people. They have a wharf here for the shipment of coal. It was at this place the atrocities were committed on the Japanese, who were leaving China by steamer. The railway connects the Kaiping coal mines (managed entirely by foreign engineers) with Tientsin and, I believe, continues 200 miles further on to Shan-hai-Quan. It is by this route that the Japanese are likely to advance on Peking.

In our journey up the river we pass numerous sea-junks which are carrying the tribute grain from the south of China and the provinces. A few years ago all the grain going up to Peking was carried by these junks, or by way of the Grand Canal. Now foreign steamers compete with them, and carry it quicker, cheaper, and safer, as there is an element of uncertainty in a voyage in a junk, which is no better than a big box, with as many masts stuck up as possible, and nearly all the rigging made of bamboo ropes.

As I came home a few years ago, the river was crowded with these sea-junks. They would not pass the English and French settlement to go to their moorings in front of the native city; and they had all struck in fact! The French were making an iron bridge across the river to the railway station, and these junks refused to pass through as it would injure their luck. The last I heard of the bridge, was that it was all taken down and every pile drawn; such is the Chinese retrograde movement in the direction of improvement.

Forty miles from Taku is Tientsin, the Port of Peking, which is 80 miles distant by road. It is on the River Pei-Ho. Steamers of light draught and gun-boats manage to get to the bund in front of the foreign settlements, but they are often stuck in the river for days. The foreign settlements have good streets and fine houses. The Chinese have built a large naval college just below it, but the native city is, like all Chinese towns, dirty, with narrow streets. It is a very busy and important city; everything from the south has to pass through it. Here Li Hung Chang, the Viceroy of Chili, has his Yamen, and spends more of his time than in Pao-ting-fu, which is the capital of Chili.

The river divides the town, and the banks are lined with junks three and four deep, unloading grain and transshipping it into smaller junks for Peking. All the grain from the junks and steamers is transshipped at Tientsin. It would astonish a merchant on the Corn Exchange to find that all the machinery required to move this immense mountain of rice and millet is simply an army of coolies, a lot of wooden boxes for measures, and a number of reed mats; the grain is emptied, measured, sacked, and sent off, the mats are picked up, and the Corn Exchange has vanished.

At the top of the reach is the *débouchure* of the Grand Canal, which swells the waters of the river and makes it a broad and rapid stream. Here also stand the burnt ruins of the French Catholic cathedral that was destroyed by the mob during the massacre of the French Sisters of Mercy in 1870; it has stood in this condition ever since, a monument of Chinese duplicity. Above here the houses become fewer, and there are no large junks above the bridge of boats. The river is crossed by two bridges of boats and many ferries.

On the banks of the river are immense mud forts; but I do not see what use they are likely to be, as the river becomes so shallow a few miles farther up that anything drawing more than three feet of water could not get along in some places. Tung Chow is the port we are going to next; it is 120 miles from Tientsin by river, and 14 miles from Peking; we must travel up in a house-boat. Nearly all the

junks that we pass are loaded with grain, making for Tung Chow, and as it is against the current the men have to track the whole of the way, unless a fair wind springs up; but it generally is tracking from long before daylight till after dark, and, as in the case of our small boat, two men pull it 30 miles a day, on such poor food that an English beggar would turn his nose up at it. I have seen 50 of these large loaded junks stuck fast in some of the shallow parts of the river, and all the crews overboard levering them off with long poles into deeper water; at the same time there was ice lining the banks of the river more than 12 inches thick. Tung Chow is the end of the river navigation and the nearest point to Peking, and everything is again transshipped; we ourselves going by land over a stone road 25 feet broad, made of large blocks of granite, six or seven feet long, 18 inches thick, and about the same width. This road continues right through the gates of the capital. As it was made about 400 years ago, and has not been repaired since, it is in a most dreadful condition, and if in England it would be considered impossible for any wheeled vehicle to pass over it. Nothing but a Chinese cart could stand the bumping and tumbling about it gets in passing over this road, which always reminds me of that scene in "Uncle Tom's Cabin" where Eliza escapes with the baby in her arms across the frozen river, by stepping on the blocks of ice. In some places the stone slabs lie at every conceivable angle: of course they do not move about.

We are now nearing Peking, which is situated in the midst of a sandy plain, in N. lat. 39°, 55; on the west, north, and partly on the east, it is bounded by mountains; on the south with the great plains of Central China; it is only about 120 feet above the sea, and a hundred miles distant as the crow flies.

The climate is a continental one, and very much like that of New York; the temperature ranging from a few degrees below zero in the winter, to several degrees above 100 Fahr. in the summer. The winters are very dry, no rain or fogs, the sun shining all day long; it begins to freeze in December and continues until March, the temperature seldom rising above 32°. Owing to this intense cold all intercourse by water is cut off for three months, the river and sea being frozen nearly as far south as Chefoo; the only communication with the outer world (except by telegraph) is by horse carrier, *viâ* Chin Kiang, a port on Yang-tze, distant from Peking 1,100 miles. The journey is done in about eleven days.

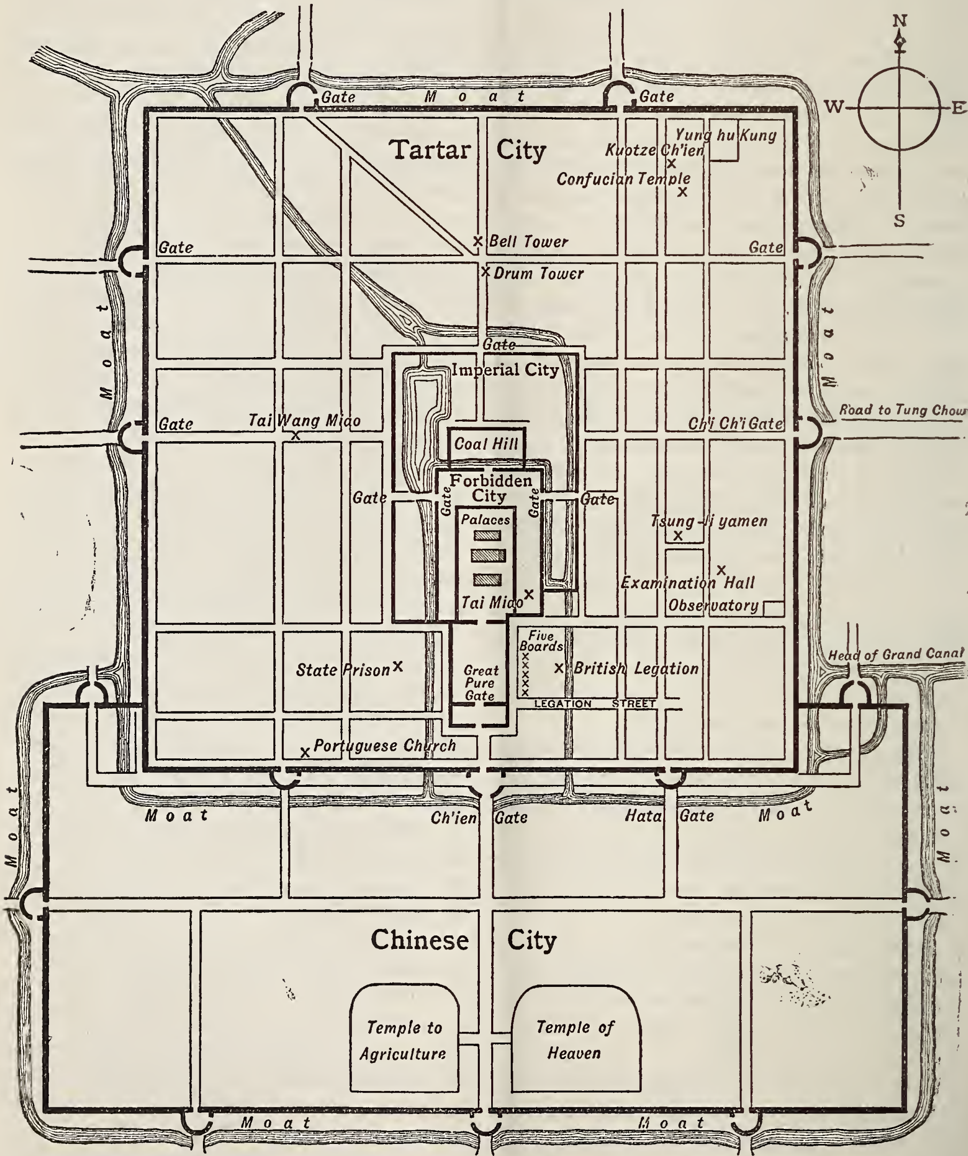
The hottest months are part of May, June, and part of July; then the rainy season is fairly on, and continues till August, with showers until October; from then until June next year scarcely any rain or snow falls. April, the early part of May, September till November are delightful months. There are in the winter great storms of wind from the north-west, sweeping from the high lands of Gobi, Mongolia, and Siberia, with terrific force and intense cold; gathering up the dry dust that is everywhere, and sweeping it along, mixed with small stones, in thick clouds, stinging the face and filling the eyes, ears, and nostrils, covering everything with a thick film and penetrating every box and bundle. It is impossible to keep it out, such is the force of the wind, which is so cold that it passes through the texture of a thick great coat as through a sieve, chilling the wearer to the marrow. The only protection against it is the skins of animals, or the cumbersome wadded garments worn by the Chinese in the winter.

In these big winds, out in the open it is impossible to make any satisfactory progress, as everything at all portable is swept before the wind. An invading army marching on Peking in the winter would suffer many hardships; and living in tents would afford little protection in such storms, even if the tents were not blown bodily away. The ground is frozen like hard rock for three feet deep, and it is almost impossible to dig in it so as to throw up an embankment for protection. Everything for use must be carried with the army, as the country round is so poor that there would be no food to be bought or stolen. On the other hand, the cold would freeze the roads hard and make them better for transport, as at other times they are sloughs of mud or dust. Had the inhabitants any more courage than sheep, an invading army would run a great risk of being destroyed.

The capital of China differs from any other city in the world. It has no towering spires or graceful minarets, no lofty chimneys or high monuments; no fine buildings or houses eight or nine stories high, to be seen in the distance and notify to the traveller that he is nearing the city; there are no buildings to be seen from the outside but the walls, and these are hidden by the houses and trees in the suburbs, so that they cannot be seen until we are close to them. By chance we may catch a glimpse of the high towers on the city gates; but coming from Tung Chow, which is the road by which

we are approaching the city, we get within half a mile before these can be seen straight down a busy street in a busy suburb. It comes upon us suddenly, and upon first sight these towers are very impressive; their solidity and size, the rows of port-holes and the number of guns, the muzzles of which appear peeping out, give the idea that it would be very hard to take; but better knowledge dispels this idea, for we find (whatever the masonry may be) that the guns are just paintings on wooden doors. This is a case of make-believe, and

PLAN OF PEKING.



not the last we shall find before leaving the city.

I have a plan of Peking made by the Chinese: it is in the form of a square four miles in the side. I am speaking now of the outside walls, which enclose the Tartar city. There are nine gates in these walls; two on the east side, two on the north side, two on the west side, and three in the south wall, which divides the Tartar from the Chinese city. The gate we have arrived at is in the east wall, and is called the Ch'i-Ch'i-men. About a mile inside these

walls in the centre of the city is another walled city, called the Imperial city; again, inside this city is another walled city, called the Forbidden City, and inside these again are the palaces. Here the Emperor lives; "such divinity doth hedge a king." No foreigner is allowed inside the Forbidden City. The Chinese city is tacked on, as it were, on the south, and extends for about half a mile east and west beyond the walls of the Tartar city. This is also enclosed by a wall about nine miles round, pierced for seven gates. It is smaller than the other, and built 100 years later. The Chinese city is much inferior to the Tartar; there are no fine buildings except the Temple of Heaven; the streets are narrow and very dirty (not that I would imply that the streets in the Tartar city are clean), and most of the business is done here. Each city is surrounded by a moat crossed by bridges at the gates.

The wall of the Tartar city, as I have already told you, is sixteen miles in circumference; it is fifty feet at the base, forty feet thick at the top, and fifty feet high. It is made of two thick outer walls, the space between being filled in with dirt dug out of the moat. On the outer face, at intervals of two arrows' flight, massive square buttresses project which enabled the archers to defend the space between them. A crenellated parapet runs entirely round the outside wall, intended for archers only. The *terreplein* throughout is paved with bricks weighing 60 lbs. each. At the gates, and also at several places in between them on the inside of the wall, are inclined planes for mounting to the top. The wall was built in 1419, and though more than four hundred years have passed away since then, very few repairs have been needed, which speaks very well for the solid manner in which it has been built; it is always kept in thorough repair. As a city wall it is without doubt the finest extant.

Each gate is surmounted by a house 99 feet high, built with wooden pillars and galleries in Chinese style. There are no buildings in the city more than 99 feet high, as the natives say the spirit of the air flies at the height of 100 feet, and I suppose they do not wish to injure his wings (?). This superstition is not confined to the common people. When the new French cathedral was completed in 1865, by ascending one of the towers, it would have been possible—as it adjoins the Imperial park—to have seen the ceremonies at the new year. To prevent this, the Chinese insisted that all steps should be removed, and a mandarin used to make periodical visits to see that they were not renewed; besides this, they elevated the wall next the cathedral to more than twice its original height, until it was higher than the tower, even on the street on the north side, where princes and courtiers pass with their suites on their way to the early morning audience with the Emperor, it was thought necessary, also, to build a high wall, to ward off evil influences, as high buildings, especially of foreign construction, are supposed to be conductors of evil influences of the spirit of the air. They interfere with what is called "Feng Shui."

Each gate has a double entrance, formed by joining the ends of a semicircular wall to the main wall, thus forming an *enceinte* of about an acre in area. Exactly in front of the main gate is a large brick tower, which is particularly impressive. It is on the circular wall, and there is no gate through it. At right angles to the main gate, this circular wall is pierced by another gate, over which is a small house. I cannot but think that these buildings were built more for effect than use, as the walls are very thick and built perfectly level on the top, so that it would be impossible to get sufficient depression, even when shooting with arrows, to be of any practical use.

The arches of the gates are built of granite, and massive wooden doors—18 inches thick—stop the opening, which is a tunnel 50 feet through the wall. Every night at sunset these doors are closed, and not opened for anyone until daylight next day.

The moat which runs round the city is fed by springs running from the Western Hills, and as there are not many houses on the banks, the waters are fairly pure. In the winter, when the moat is frozen, it is crowded with omnibus sledges, pulled by men plying for hire. Several times during the winter, when the ice is about 18 inches thick, it is cut and stored under mats for use in the summer.

Outside the gates under the semicircular wall is always a busy place; there is a continuous string of carts and foot passengers so long as the gates are open, and shopkeepers have built and opened a sort of bazaar, where articles of such a style as may be purchased at the Lowther-arcade are disposed of in abundance. The gateways and the paths inside the tunnels of the gates are paved with big granite slabs, like the stone road put down when the

wall was built, and never taken up for repair since. I should not be conveying any idea of the state of the pavement in saying it was bad; all the adjectives in the English language would not describe its badness; it must be passed over in a Chinese cart to get a proper conception of its state.

On each corner of the walls are immense buildings, built on the angle of the wall, similar in style to the towers on the gate, and, I should think, about as useful. There is a wide road between the south wall and the moat; it is inside the Chinese city. Past the south-east corner of the Tartar city is the route from Tung Chow. There are generally a number of carts and barrows making for the only gate, where duty can be paid on goods entering the city. Where the moat passes under the city walls, the arches are carefully closed by iron gratings, so that a man could not get even his head through. A small stone bridge, without a parapet, spans these places, and makes a continuous road round the city, which would otherwise be broken by these streams, and there are several coming under the wall.

Up to the present we have wandered round the outside of the wall: we will now pass through the gate, threading our way amidst the crowd of miscellaneous vehicles and animals that straggle all over the road (there is no path), each one trying to pick out the smoothest piece, the carts rolling and tumbling about in a most alarming manner, one wheel at a time suddenly dropping into a hole twelve inches deep, the concussion jerking the other wheel off the ground, and, as likely as not, overturning the cart, thus adding to the danger of foot passengers. Getting in through these gates is as bad as crossing a London street, supposing there were no regulations in the traffic. To repair an Imperial road or ruin without an Imperial order would be looked upon as great presumption, and is a punishable offence; so the holes in the pavements of the gates and the stone roads are stumbled over, and no one grumbles. Year by year, as generation after generation passes away, slowly but surely the mischief goes on increasing. I may add here that I have never seen a four-wheeled vehicle in China; everything is carried on two wheels or on barrows.

Being inside the city, we will mount the walls by the inclined planes, which are closed at the bottom by a wooden gate, kept by a guard, who is quite willing, for a small consideration, to let us go up. From the top of the wall we get a good view of the city. The first thing that strikes any one in looking across the city is the quantity of trees that spread out and hide the houses and shops, and the absence of high buildings—all the houses being of one storey. In the summer (except the houses in the immediate vicinity) there is nothing to be seen but green trees, until the eye catches the tall palace buildings in the centre of the city. In the winter, the trees being leafless, more of the housetops can be seen.

Looking from the top of the gate, before us is a fine, wide street; there are many such. All the principal streets running across the city, from the gates, are broad and unpaved; they are from 100 to 120 feet wide, but look wider, the lowness of the houses making them appear so; they all run in straight lines—north to south and east to west—a city of parallelograms. Nearly all the shops are in these streets, though, of course, there are some places busier than others. In between the big streets are smaller ones, and lanes, in which are situated most of the private houses, which present nothing but a brick wall and a door to the street, the house lying back in its own compound. These lanes are very narrow and unpaved; there is hardly room for two carts to pass each other. As all the coal ashes and other refuse are thrown into the street, Peking is gradually burying itself in its own ashes. In parts of the streets, down the centre, where there is a hollow, a sort of causeway, about 20 feet wide, is made up from the dirt dug out from the sides, leaving great holes that take the surface water during heavy rains, and forming a convenient receptacle for miscellaneous slops from the houses and shops on the side. Thus, during some of the hottest months of summer, green, stagnant pools are lying by the sides of the streets, the water from which, scooped up with a basket on a stick, conveniently serves to sprinkle the road every evening. Men with long, fine nets skim the surface for the larvæ of the mosquito to feed goldfish. In the evening, numerous men and boys are to be seen with a piece of cotton wool dangling from the end of a stick in one hand, and a butterfly-net in the other, trying to catch the large dragon flies that hover over these pools. Many cases have been reported of people having been drowned in the streets of the capital during the rainy season. When the streets are two feet deep in mud, and in many places several feet under water, the policemen stick up poles or pieces of reed on the edge of this raised causeway to prevent the carriages from tumbling into the holes on

the sides, for it is a city of veritable pitfalls. There is a splendid system of sewers, but, with true Chinese perverseness, the tops are above the ground, and the parts that are below are full of dirt washed in from the street, so that a very small portion is available for carrying off the water. After many days, and sometimes weeks, of this mud, constantly churned up by the cart-wheels, as soon as it gets a little dry the policemen dig down to the hard ground, shovelling the mud up in heaps to dry in the sun; when dry, it is again used for mending the roads. Getting about during this state of mud is an unpleasant affair, and would be much worse were it not for the material the natives make their shoes of. The rag soles soak up the wet, and so soon as it leaves off raining, a little path following the places where the mud is shallowest is formed by the feet of the walkers, and the whole city marches single file along these paths.

Walking south, along the top of the wall, we find it like a paved street, 40 feet wide, clean and dry, the only clean walk in Peking: as the general public are not allowed up (nor Chinese women by any chance), we admire the view and walk in comfort, free from dirt and the dirtier crowd. The only people that we meet are the guards, that live in little houses built on the top of the wall, and pass away their time in smoking, gambling, and sleeping. Straight before us we see a large square block of masonry, 20 feet above the wall; it protrudes half across the path; this is the terrace of the celebrated Observatory, which we shall see anon. The view from here across the city shows us the Examination-hall, and we also get a peep into the yards of the houses of the middle-class, and see the peculiar manner in which the roofs are tiled. As I have such a large subject before me I shall not dwell long on these things, but pass on to more important matters. We have now got up to the corner of the east wall, and looking from the city across the country, right under us, we see the last lock of the Grand Canal, one of the largest pieces of hydraulic engineering in the world and one reflecting much more credit on the monarch who executed it than does the great wall. If the time in which it was dug is taken into consideration (the 13th century), it must be allowed to be a marvellous work. When it was in good order an uninterrupted water communication existed across the country from Canton to Peking; advantages were taken of rivers and lakes, but besides these helps, there are about 650 miles of excavating, and this last piece, from Tung Chow to Peking, 14 miles, shows, in my opinion, a great want of ingenuity, as there are no less than five different levels. Instead of having locks, so that the same boats could bring their cargo up to the walls, they unload and tranship five different times, five porterages in 14 miles of level country! and when we think of the vast quantity of Government grain only, 7,000 to 8,000 tons every year, we find an illustration of the lack of enterprise and the love of doing things in the most roundabout manner that is seen in the Chinese character. Of course this affords employment to many thousands of men; any beggar that can carry a sack—it weighs 260 lbs.—picks it up and does so, and for this he is paid a few cash; he need not carry more than one, and he is paid for what he carries. As an argument against the introduction of railways, the question is asked, What is to become of the thousands that do this kind of work? You can also see from here the little tower on the north-east corner of the Chinese city wall.

The next gate we arrive at is Ha-ta-Mên, it is the east gate in the south wall that separates the two cities. It is a most important gate, and all goods entering the city have to pay duty here. In the middle of the day it is difficult to get past owing to the crowds of loaded carts, barrows, and animals. In the ninth month, just before the Mandarins' term of office expires—they are only in office for one year—for about twenty days the duty on all goods is lowered, and during that time there is a great import into the ctty; this is done to increase the revenue, but I am afraid little of it finds its way into the coffers of the Emperor.

A little farther south we can see the British Legation and the canal that rnns in front, flowing from the moats in the Imperial city into the moat outside the walls; there is very little to be seen but roofs. Continuing west, we arrive at the centre gate; it is the principal gate in the city, and is called the Ch'ien-mên. It differs from the others in having three entrances instead of one in the circling wall. The one opposite the main gate passes under the tall brick tower, and this is only used by the Emperor when on his way to the Temple of Heaven, the two side gates are used by the public; and here is the busiest place in the city. The small building in the corner is a temple to Kuan-ti, the god of war, and is much frequented. Straight in front of this gate to the north, inside the city, is the "great pure gate" leading into the Forbidden City, it is

only used by the Emperor or Empress, and as the latter never leaves the palace, it was only used by her when she was carried in at midnight to wed the Emperor; this is the best position to see the tall buildings of the palaces. Although there is a constant stream of carriages and people passing in and out of the city, no one is allowed to cross the forecourt in front of this gate, everything must go round the outside.

Turning round and looking south towards the Chinese city, right under us is a great crowd of carriages and people, on what is known to foreigners as the "beggar's bridge," from the great number of beggars that swarm here; the queen of the beggars holds her state somewhere in this locality. In the distance the Temple of Heaven rears its triple roof above the dense mass of shops and houses; it is the only tall building in this city.

Continuing west, we pass the ancient Portuguese cathedral, right under the wall; it was built by the Jesuits in 1661, by permission of the Emperor. On the return to Peking of the Roman missionaries—after having been driven out of the empire—they found the cathedral just as it had been left 120 years before, in possession of a numerous colony of pigeons, and the accumulation of their manure sold for as much money as paid for the cleaning and repairs of the place.

The next gate close by is one that a live emperor must not pass through; it is the "dead gate," and criminals on their way to execution pass out of it. There are only certain gates that a corpse can be allowed to pass through. When the Eastern Empress died—the late Emperor's stepmother—her body was carried out of one gate, whilst the Emperor following it went out at another, because a live emperor could not pass through that gate. No dead body is allowed to be brought into the city, neither can one inside be allowed to cross the city in front of the palace.

Returning to the gate we entered the city by, and coming down from the wall, we pass along the small streets and lanes to the left of the gate, and arrive at the Peking Observatory, the oldest in the world, and, perhaps, the most dilapidated. Like nearly all things in China, its time has passed, and to render it of any use, it would not only require a new set of instruments, but new men with modern ideas also. Anyone expecting to find highly-finished, shining, brass instruments, such as are found in Western observatories, will be disappointed; were the instruments not made of imperishable material they would have disappeared centuries ago, having been made in 1275, when the observatory was founded by the Mongol Emperor Kublai Khan. Two of these instruments have been out in the open, exposed to all weathers ever since. The front gate is not a very imposing structure, but it carries the marks of age. I have never seen it used, a gate round one end serving the purpose for entering the court yard, where we see, in front of us, the principal building of the Observatory, with the doors sealed up, in no better condition than the front gate. In front of these houses are the two instruments made by the Mongol Emperor, an armillary sphere, supported by four dragons—the Chinese say, and believe, that there were originally five, but one flew away, so the other four have been chained up by the forearm. By the side of this is an astrolabe of the same date; both instruments are beautiful specimens of the moulder's art, and are among the finest pieces of bronze extant. Notwithstanding their exposure, they are just as sharp and smooth as when turned out of the hands of the workmen 600 years ago. This Observatory is immediately under the east wall of the city, and turning round to face the wall, we have the square terrace that we passed on the city wall right before us; it is 70 feet high from the ground, and has steps running round two sides to ascend to the top, where are placed eight instruments of later date, one being a bronze celestial globe, 7 feet 6 inches in diameter, with the constellations standing out in relief on its surface. All these newer instruments were made by the Jesuits about 150 years ago. Taken as a whole, I should think this is the finest collection of bronze in the world.

Although so many years have elapsed since the Mongol conqueror ordered astronomical instruments to be made in Peking, and they have withstood the frosts and heats of so many decades without the slightest injury, could we see them after the lapse of a similar period in the future, we should probably find them in the same perfect condition—like the nation, time changes but little.

In the existence of such a people as the Chinese, 600 years are as nothing; dynasties come and pass away. Other nations are ever changing, but this mighty people remain, with scarcely any difference, what they were hundreds of years ago, in spite of famines, floods, wars, and civil contentions, destructive enough to human life and property to exterminate many a smaller country. In the late Tai-ping rebellion, during the 14 years it

lasted, 20,000,000 human beings are said to have perished; but the people are like the rising tide, irrepressible, and, in spite of every effort to keep them back, they are advancing and overflowing into other countries, and must do so.

Peking, as a city with its monuments and temples, bears indisputable evidence of old age. During many reigns, very little money has been spent in the repairs of the useful parts of the city; the Observatory, with such gems of workmanship, must have been in a chronic state of decay for years. The instruments do not show it, but the bricks and mortar all over the city show the wear and tear of the ages. The north-west wind that blows with such force, bringing with it clouds of sand, forms a perfect and destructive sand-blast, which cuts away the centre of the bricks that are exposed to its force. In all the old brickwork facing the north-west, the middle of the face of the bricks is scooped out, while the hard skin remains with the mortar like a frame round it—this is all the effect of the dust.

Probably any other nation would have its Observatory under cover as much as possible—this is another proof of the Chinese doing things contrary to European notions; even the outside walls are in a tumbledown state, leaving the yard open to the street, and children avail themselves of it for a playground, climbing and tumbling about the instruments, but, fortunately, doing more harm to their shins and clothes than to the bronze. Trees grow in various parts of the yard, between the joints of the brickwork and through the cracks in the stones, displacing with their roots the level of the instruments. Before I could photograph one of them, I had to wait several months until a large tree that had been blown down and covered it up, had been stolen little by little. A guard of Manchu soldiers are constantly on duty, but their principal business seems to be extracting the money from visitors.

The buildings on the north side seem to be the place where work was done, as they contain large and heavy tables, with a thick carpet of dust on them. The windows extend along the south side of the building; they are like those of ordinary Chinese houses, made with a wooden framework, which is pasted over on the inside with paper. This lets in light, and keeps out cold; but the view from the inside is somewhat restricted. As all the paper that was on these windows had been eaten off by wasps, the thick carpet of dust on the floors and furniture is easily accounted for. The roof is covered with yellow porcelain tiles, the Imperial colour. All the palace buildings are so roofed; but this, like the rest of the place, is much out of repair.

Near to this place is the Examination-hall, in the yard of which are 15,000 small cells, 3 feet wide by 4 feet deep, open at the front, and containing only a piece of board for a seat, and another piece for a table. To protect himself from the weather, and make the place more private, the candidate buys a piece of mat, and hangs it up in front as a blind. In each of these cells one candidate is shut up for two nights and one day, and not allowed to leave under any pretence. The food is cooked and supplied by men employed by the Government, one coolie being allowed to ten men. The food is white rice only, any other luxury being provided by the students themselves. During the day of entering, the candidates flock in, and are searched by the numerous Mandarins in attendance. No book or writing material is allowed inside: their places are allotted, and the gates closed. Then a committee of Mandarins determine what the subject to be written upon is to be. This is handed to the wood-block engraver, it is cut, printed, and handed round to the different men, each question being the same. The candidate has a plain book handed to him with his name bound up in the cover, so that he is compelled to use the book supplied by the Government. The subjects are quotations from the Chinese classics, a character or two only being given, the student having to take up the theme if he can. Candidates from all parts of the empire flock to Peking, and at the great examination as many as 15,000 enter. Many die, and their bodies are thrust out through a hole in the wall provided for that purpose, where there are benevolent persons waiting to take the corpse and bury it at their own expense. The Chinese say —here superstition comes in again—that ghosts wander about at night up and down the alleys of cells, lifting the curtains and peeping into the little rooms; when the unlucky person is found against whom the ghosts have a spite, they rush in and strangle him. Common sense says it is a case of suicide. The graduate finding he cannot do the paper, and not having the courage to return to his village a failure, ends his life. When we think that out of this great number there can only be about 200 take the M.A. degree, we see how slight a chance there is for many. Yet all the examination-halls

throughout the land are perpetually crowded, and if we consider the amount of mental toil which the mere entrance to any of these examinations involves, we get a very vivid conception of the intellectual industry of the Chinese. In what land but China would it be possible to find examples of a grandfather, son, and grandson all competing in the same examination for the same degree? Many memorials have appeared in the *Peking Gazette* relating to the aged candidates. At the provincial examinations in one of the provinces 35 of the competitors were over 80, and 18 over 90 years of age! Could any country in the world afford a spectacle like this?

Continuing our journey westward among the lanes, we find fine buildings and hovels all grouped together, the prince having for his neighbour the small tradesman, and each equally proud, the trader considering himself as good as the prince. To be in business is no disgrace, on the contrary, it is considered an honour, and a man who deals in matches thinks as much of his position as a banker. They are both serving the commonwealth, and both useful in their own way. I once overtook a man in the country, and he told me he had seen our "firewheel boats" at Tientsin, where he had been a merchant. I thought I had got hold of a big swell, and inquired where his offices were. He informed me he had no offices, he dealt in needles. He saw nothing to laugh at in the matter; it was an honourable occupation, and something to be proud of. In one of these narrow lanes we find the Tsung li Yamen, the Chinese Foreign Office. Inside the gate is a portal on which are four characters, meaning "Prosperity at home and abroad." The buildings inside are of the usual Chinese style of one storey, with paper windows, the principal rooms facing south, all with brick floors. This is one reason why the Chinese have such thick soles to their boots. A Chinese room, to our Western ideas, lacks comfort as there are no chimneys in the houses; the fires are made in pots in the middle of the room, and though smokeless coal is used, there is a certain amount of fumes that are not at all pleasant. The fire is not so much for heating the room as for making water hot for tea, and they depend on their clothes for warmth in the winter. At this place there is a college, under foreign professors, for teaching the Chinese languages and science, the students being fed and paid a monthly salary to come and study.

Passing on, we go through the fore-court of a prince, and pass the front door, not of his house, but of his court-yard, the houses are out of sight; they are a series of one storey rooms, with paper windows and brick floors. The front hall that we are passing is a very large building, with stone lions on either side of the steps; it is the regular custom to have bronze or stone lions outside these large residences. The gardens inside are laid out very beautifully, nature is imitated in a miniature way with rock, water, and trees. If a Chinaman has only a few feet for a back yard he will try and introduce some rocks and water. We arrive at length on one of the big streets, with its fine shops, many with carved and gilded fronts. The shops, so different from our idea of them, are all open in the front to the street, with no windows in which to exhibit their wares to tempt the money out of people's pockets. It is as well to know what is required before going into them. The shopkeepers are a hard-working class, up with the sun, and the shops are swept ready for customers almost before it is well light. There is no Thursday closing, or Sunday either, and, so far as I know, no grumbling; about the only holiday is New Year's-day, then all shops are shut. The streets, though wide, are much cumbered by booths and stalls, some of them quite substantial structures, others taken down at night; here gathered under an awning is a large audience seated on benches listening to a story teller, on the outside is a man with a huge teapot well wrapped up in cotton-wool, as they do not possess any flannel, to keep the tea warm until he can sell it out at one cash a cup. Another man has a fire with an iron girdle on the top, on which he is cooking, in oil, little tasty-smelling lots of mutton and onions. I may state I never saw dog's flesh offered for sale, or anything in the way of meat worse than a donkey. I have seen very poor people dragging away dogs, and have been told they would eat them; but that was because they could not get anything better, not from choice. But this is a very long subject, and I had better pass on.

Among other curious things we are sure to see is a bier arranged out on the street. Funerals are great institutions in Peking; in fact, these and weddings seem to be the only jolly times the poor folks have; they are both made a time of feasting, and, to us foreigners, one seems about as gay as the other. This bier is waiting for the coffin, the funeral taking place the day after the bier is erected in the

street, when the coffin is placed on it; the whole structure is borne on the shoulders of sixty-four men, and carried to the grave; it is very heavy, and must weigh much more than a ton. Fancy erecting a structure like this in the middle of the Strand! The traffic has to go where it can. Beggars we are certain to see; I once photographed a group of them and gave them each one shilling; they grumbled at the little money, and accused me of wasting their time. As distances are great, it is as well to take a cab, of which we see many hundreds in the streets; we foreigners call them carts. It is just a box on wheels, without springs, covered on the top with a wooden framework, over which is stretched blue shirting; the wheels are very heavy, the axles, of hard wood three inches in diameter, stick out beyond the wheels about six inches. The driver sits on one side of the shafts, but, before he starts, he takes a brush out of a little bottle that hangs by the side, and oils the wheels; under his seat, under the cart, is a basket and a little tub, the one is a nose-bag, and the other is a tub to supply the animal with water. When the horse is feeding it is used to stand the basket on. The proper way is to get inside these carts and sit tailor-fashion, but the rough roads and lack of springs cause us to alter our minds and sit like the driver, on the other side of the shafts; this is by no means *comme il faut*, and never adopted by any respectable Chinaman, but we think it better to withstand custom for the sake of moderate comfort. These vehicles have a blind that can be let down over the front, but it in no way keeps out the cold or dust. As Chinese etiquette demands that one gentleman shall not pass another if he knows him without dismounting if riding, or getting out of the cart if driving, and making a formal bow and greeting, the journey has many breaks and is necessarily slow. To get out of this greeting ceremony the blind is let down in the cart and the passengers pretend they are not there, and get on their journey as fast as they can.

By this time we have arrived at Legation Street. It runs parallel and near to the south wall of the city. The whole of the Legations and the Inspectorate of Chinese Maritime Customs are within an area of half a mile. They are nearly all situated in parks surrounded by high walls. There is nothing to be seen from the streets but the gates and walls, except the British Legation, which has built several two-storied houses; and the tops of these can be seen from some distance. The Russian Legation is the oldest, having existed in Peking for over a hundred years. Near the Legations are the principal Government offices. Five of the six Boards are on the east of the Imperial city, and one, the Board of Punishment, on the west. There is nothing particular to call attention to in these buildings, they are built in the usual Chinese style of one storey and a large court-yard in front, with perhaps more than the usual quantity of dirt and dilapidation.

The Board of Punishment, called the "hsing pu," on the west, is the best known; it is the State prison, and cannot be visited by foreigners unless they stay, and I have never heard any one express a wish to do so. The late Sir Harry Parkes describes the horror he felt when he passed within its chained gate. Like the Examination-hall there is a hole in the north-west corner of the wall through which the bodies of the unfortunates done to death are thrust. I do not think prisoners are actually executed within the walls, they are only tortured to death. There is a public execution-ground outside in the Chinese city.

Following the canal by the front of the British Legation brings us to the corner of the wall of the Imperial city. It is about six feet thick and twenty-five feet high, and seven miles round; the top is roofed with yellow porcelain tiles. This is a characteristic of Peking, all the public buildings are covered with these glazed tiles, every dynasty having its own colour, some green, some yellow. The present dynasty, which is the "ch'ing" or "pure," has adopted yellow. All the palace buildings are covered with tiles of this colour. There is a moat inside the walls, crossed in various places by stone bridges. The city is entered by three gates, one in the east wall, one in the north wall, and one in the west wall. I have already spoken of another, the "great pure gate" in the south; but as that is not for common people I do not notice it again. These gates are inside a large hall; they are not closed at night. As the Emperor transacts all State business very early in the morning, Mandarins are constantly coming and going; and when lazy people get up to go to business about nine in the morning, crowds of these courtiers and their suites are to be seen hastening home, after their early audience with the Emperor. About half a mile inside these gates are the gates of the Forbidden City, something like the large gates in the big wall of the Tartar city. As that is very much forbidden ground,

we pass on, and in the centre of the city—still forbidden—is a hill about 300 feet high, said to be composed entirely of coal, for use in case of a siege. There are five pavilions on the top, that were built during the Ming Dynasty. It was here that the last Emperor of the Ming dynasty, finding all was lost, hanged himself—the Chinese say on a crab-apple tree—and the tree can be seen to this day in chains. I inquired if it was not foolish to put a tree in chains? They said, "No; the tree has sinned, and must be punished."

On the south of this coal-hill is a broad moat that encircles the Forbidden City, and on the other side are the walls; they are two and a quarter miles round, guarded by numerous stations of bannermen. There are three gates into this city: no one but Chinamen that have official business and wear official hats are allowed to enter; no person, whatever his position, is allowed to drive, ride, or be carried in a chair inside this city—all dismount at the gates. According to the notions of the common folk, all here is gold and silver. They will tell you of gold and silver pillars, gold and silver roofs, gold and silver vases in which swim gold and silver fish. All this part of the city is just as it was left by the Mings in 1644. When the conquering Manchus swarmed in, they found a magnificent city and palaces all ready for them, uninjured and strong, which were apportioned among the victorious army for habitation. This army consisted, not only of Manchus, but of Mongols and Chinese, and was divided into eight banners; thus they were called bannermen, and very few Chinese merchants were allowed to reside in the Tartar city. The Chinese, called "Min Jen," were obliged to live in the southern Chinese city. Partly by intermarrying among the banners of different nationalities, and, in much rarer cases, among the ordinary Chinese, the Manchu element has become almost absorbed, and the Manchu language, as a living language, has disappeared in Peking, though it is still used as the Court language. The greater mass of the population strikes the observer who comes from the south as taller and stronger built, which shows the mixture of the Manchu blood. Until within the last fifty years the whole population of the Tartar city consisted of bannermen, but now there are many Chinese among them. These bannermen are the virtual army of Peking, and it costs the Government £160,000 every month to keep them on starvation pay. They form the whole of the police, amounting to 12,000 men, most miserably clad. They are the firemen, and also keep the streets in repair. As a class, the bannermen are lazy and proud; as soldiers, there is the making of good men in them if they were properly trained; at present they are worse-armed and trained than any soldier in China. Many are armed with bows and arrows. Skill in archery and great physical strength are deemed of more importance than any other attainments relating to war.

On the north side of the moat, not in the forbidden part, is the Temple "Ta-Hao-tien." It is used by the Emperor when any national circumstance demands prayer, such as want of rain or snow. It has three portals, one on the east, one on the south, and one on the west. The Emperor enters by the southern one. They are made of wood, beautifully lacquered and painted. There are two houses with very complicated roofs, covered with yellow tiles, just inside. These would be used by the guard during the Emperor's visit.

The road runs right through the palace gardens, crossing a fine lake by a marble bridge. From here we get a peep at the inside. This is one of the most beautiful spots in the city. The lake, more than a mile long, in summer is covered with a mass of lotus, whose round leaves form a carpet of green, dotted with myriads of pink flowers as large as basins, which help to make a beautiful picture that anyone could admire; the perfume from the flowers, wafted by the wind, can be smelt half across the city. In winter the lake is covered with ice as clear as crystal, on which the Imperial family disport with sledges. On the banks of the lake are handsome summer-houses and temples, beautiful groves and examples of the art of landscape gardening, in which the Chinese excel. The hill, which is an island, is capped by a marble dagoba. Here there is an altar to the originator of the silk manufactures and to the presiding genii of the silkworm; round it are mulberry trees. The Empress comes here annually to feed the silkworms; she thus sets an example of industry to the working women of the empire. The building to the right is a temple dating from the Mongol times. The high wall is overhung with the branches of the white pine, which only grows round Peking. It is now impossible to go on this bridge as the Emperor Kuang-Ssü has ordered the road across it to be closed, and anyone now wishing to cross the city has to make a detour round the wall of the Imperial city.

On the south-east side of the palace is the

"Tai-Miao," the Temple of Ancestors. It is the family temple of the Emperor, and more honoured than any religious structure, except the Temple of Heaven. To be on the south, and also on the east of the palace, is the summit of honour.

In the street leading to the west gate is another celebrated temple, dating from the 16th century. It is called "Li-tai-wang-Miao," dedicated to the kings and emperors of all dynasties, containing tablets inscribed with their names. It is an impressive sight, these simple tablets of men who once ruled this kingdom, standing here side by side, worshipped by their successors, that their spirits may bless the State. On our way we cannot help but notice wooden arches that span the street in various places. I think in these cases they are just for ornament, and seem to mark a locality; some of them are in the last stages of decay. The street lamps are most substantial structures: a wooden lantern, glazed with paper, standing on four legs. The illumination is not at all in proportion to the strength of the lamp. The light is obtained from a small clay saucer, with oil, in which is a small wick, and it just serves the purpose of preventing persons running into the lamp; as they are only lighted on moonlight nights, they may be credited with lighting the city.

Continuing our journey out of the north gate of the Imperial city, we come to a most substantial brick structure, 99 feet high, and about 50 feet square, with tunnels running through it in the form of a cross. This is the Drum Tower, containing a large drum, which is beaten in times of alarm, and to give the watches of the night. A little to the north of it is the Bell Tower, in which is hung one of the five bells which the Emperor Yung Lo (second emperor of the Ming dynasty) caused to be cast at the beginning of the 15th century. The bell weighs 120,000 lbs., and is covered inside and out with 250,000 Chinese characters. This tower was built by the Emperor Ch'ien Lung of this dynasty, the bell having formerly been hung on an open scaffold.

There is a large Mohammedan population. All the sheep killed in the city are killed by Mohammedan butchers. There are also several mosques. Chinese historians say that the Emperor Ch'ien Lung built one for his favourite wife, who was a princess from a tribe of Turkestan.

In the north-east of the city is a most famous Buddhist temple, the Yung-Ho-Kung, or "Lamasary of Eternal Peace," where 1,500 Mongol and Tibetan priests study the dogmas of Buddhism, or spend their days in idleness, under the control of a Gegan or living Buddha. The rehearsal of the prayers and chants by so many men is very fine and impressive. They chant the prayers and drink porridge out of a pail. There is a wooden gilded idol of Mait re ya, the coming Buddha, 70 feet high. The priests in this temple are very rough, and though they are prepared to show visitors round and take their money, they will stand no nonsense; I mean, they will not allow globe trotters to steal the little idols that line the wall in thousands. They reserve that privilege to themselves; they are most averse to photography, and several times I have been bundled out with all my kit, pretty roughly. The Mongols are of a different temperament to the Chinese; where the latter would put up with an amount of insult provided it paid, the Mongol would adopt the old English argument and punch your head. There is a Buddhist Bible in this temple, unabridged, complete in 400 volumes.

We often accuse the Chinese of doing things topsy-turvy, and, among other things, of putting on the roof of a house before they build the walls; this is a fact, and we pass a temple in which they are working on the roof before a brick is put to the walls. In building they do not trust to the walls for supporting the roof, they are used to stop up the sides; the roof is supported on posts which, in course of time, rot at the bottom and let it down.

Within a short distance is the Confucian temple, embowered in a grove of ancient cypress trees, said to be more than 1,000 years old; the building is a fine imposing structure, from 40 to 50 feet high, supported on thick, teak pillars, brought from south-west China. In front is a broad and handsome terrace with balustrades in white marble; it is ascended on three sides by 17 marble steps. There are no idols in this place, simply tablets to Confucius and the other sages; the inscription is in Chinese and Manchu. All is simple and quiet here; the scene presents an impressive instance of the merited honour paid to the moral teachers of the people. Round the roof are hung handsome tablets in praise of Confucius; each Emperor presents one in token of veneration for the sage. Every inscription is different, and presents some aspect of his influence. He is called, "Of all born men the most unrivalled," "Equal with heaven and earth," and there are many such sentences in this strain.

Here the Emperor or his representative worships the great sage twice a year. In front of this hall is a handsome portal in which are the celebrated stone drums; they are believed to date from the Chin dynasty, 200 years after Confucius, and to be, therefore, about 2,000 years old; as the characters were becoming illegible, the Emperor Ch'ien Lung had some new stones cut, and placed on the south side of the gateway. In front of them is the court of the triennial examinations for the highest literary degree of the Chinese, "Chin Shih" (doctor of literature). A stone is here erected in commemoration of each examination, and the names and residences of all who have received this title is inscribed on them; the oldest are three still remaining of the Yuan dynasty, five centuries ago, and up to the present time the monuments are nearly complete.

Adjoining the Confucian temple is the Pi Yung Kung, or the Hall of the Classics; it is generally known as the Kuotze Chien. Besides the beautiful hall built by the Emperor Ch'ien Lung, in the centre of a marble pond, there is a magnificent porcelain arch, covered with yellow tiles, and on each side of the place, in long cloisters, stand 200 upright stone monuments, engraved on both sides; which contain the complete text of the nine classics.

These are about the principal things to be seen inside the City of Peking.

I have endeavoured this evening to give you a general opinion of what Peking is like. I have refrained, as much as possible, from entering into many details, as it would be impossible, in one evening, to notice the many important places in the city. In an ancient city like Peking, with everything so strange to Western ideas, all one sees naturally excites curiosity, and there is an abundance of facts connected with almost everything. I have told you only what I know to be true, or what has been related to me by the natives, and I have endeavoured to verify as much as I could by photographs taken by myself, most of them by the collodion process. I am not asking you to consider them as works of art, as I have had to get many under great difficulties, and have only used them this evening to illustrate my subject, and make it easier for me to convey the ideas I wish to give you.

DISCUSSION.

Mr. JOHN O'CONNOR said the paper, so beautifully illustrated as it had been, was especially interesting at the present moment, bringing before the audience as it did, a decaying system, if not one which had absolutely decayed, but he could not help regretting the tone of the paper. There seemed to be no sympathy for a system which must at any rate have been useful in some period of its history. They had seen the walls of Peking which must have been built to guard something, and in spite of what had been said he thought it had guarded a civilization which was by no means to be contemned. There were works of art, and of science, and even a system of sewers, and a college. The wonder was not that these things were bad, but that they were there at all. And some of these things were established before Rome was built. Chinese civilisation was established when Egypt was civilised, but when all the world around was barbarous; and yet it had survived. The beautiful astronomical instruments showed that there was a system of astronomy, probably even in the time of Ptolemy, and many other things dated back long before the Christian era. It was stated in that room not long ago that gunpowder was known to the Chinese centuries before it was discovered in Europe. The street lamps had been laughed at, but he had seen lamps no better in the streets of cities in the United Kingdom, and London itself was not very well lighted a comparatively few years ago. The British were rather too prone to sneer at the civilisation of other peoples, especially of those they had conquered. The civilisation of Egypt and of Rome had passed away, but that of China remained to the present day; and it had some things which were even now deemed worthy of imitation by many people, as, for instance, land nationalisation. This ancient system had at last come into conflict with European civilisation, which was all founded on that of Rome and on Roman law, and it was crumbling before it. He remembered reading a statement some years ago, by Lord Wolseley, that China was the great danger to European civilisation, and that the people were so numerous, so brave, and so intelligent that if a Chinese Napoleon were to arise, he could march an army of Chinamen through the very heart of Europe. They saw now, with some gratification, that that danger was passing away; that ancient civilisation coming in contact with the very smallest point of Western civilisation, which had been adopted by Japan, was crumbling. He had noticed, on recent visits to America, that there were not so many Chinese there as formerly, owing to the Garry law, and, in fact, all countries had found it necessary to protect themselves against the peaceful invasion of the Chinese, because they lowered the condition of life wherever they penetrated in large numbers.

Mr. W. G. TREWBY said he had always understood that mining was not much carried on in China, but there must have been a great deal of mining to produce the large stock of coal which had been described as forming quite a hill. He should like to know if Mr. Child could say at what period it was collected.

Mr. CHILD said it was collected under the Mings, about 300 years ago. It was an error to suppose there was no mining in China. Nothing but coal was burned in Peking, a very excellent kind of anthracite, which came from the western hills. It was not the mining, but the transport, which caused the difficulty; it was all brought on the backs of camels or mules. He was sorry to have produced the impression that he looked contemptuously on the Chinese; no one sympathised with them more than he did; and he had a great respect for them and for their civilisation. In fact, he was prepared to say that they were the coming race. When Englishmen had gone off the world, because they could not afford to live on it, Chinamen would come forward, and take their place; and possibly there might some day be a Chinese audience in that hall.

Mr. FRANCIS COBB said Mr. Child had been a great many years in China, endeavouring to promulgate civilised ideas; but he would defy anyone to be long in China without feeling some irritation at the peculiar way in which he was met at every step by an imperceptible something which always blocked the way. When you thought you were making way, you found in a few days that the surface which you thought you had penetrated was just as smooth as before. No doubt that had been Mr. Child's experience. But a great change had been coming over China for some time, and was getting quite perceptible. They were advancing—not with a rush like the Japanese—but solidly. But you did not find that in Peking. There the imperial family resided, and governed everything by the old rules of policy which existed probably 2,000 years ago. There was no doubt, however, that whilst in some matters they had retrograded, in many others, especially in manufactures, they had improved greatly. Silk, for instance, was much improved since the introduction of European methods; and the export of manufactured silk and also of cotton goods had largely increased, and English and American cotton goods were not nearly so much in demand, owing to the improvements in the native manufacture. He must say he had not noticed any evidence of contempt in the paper, such as Mr. O'Connor spoke of, and had no doubt that Mr. Child's sympathies were entirely with the Chinese; but doubtless he had had some cause for irritation. They had heard a wonderfully interesting account of Peking, accompanied by illustrations, which had been obtained only with the greatest difficulty. As Mr. Child had told them, he had been bundled out from many places, and his camera broken, and he could only say that if he (Mr. Cobb) had attempted to take views when he was in China, he should not have been there that evening probably.

The CHAIRMAN, in proposing a cordial vote of thanks to Mr. Child, said he could bear testimony of the accuracy of his description of Peking and its surroundings. Peking was an extremely interesting, city, not only from its present associations, but from its past history, or rather from the history of the site. So far back as the 10th century the city of Yenchow which was the capital of the Liao dynasty, stood very nearly on the site of the present Peking. The Sung dynasty, which succeeded, took possession of this capital, altered it considerably, and made practically a new city of it. Later, when Marco Polo visited China, he found the Emperor Kublai Khan living in a city then called Khanbalik, which covered part of the site of the present Peking. The walls of the existing city were built in the 15th century. There had thus been a succession of capitals on the same site, and the remains of the old cities were still to be traced by the mounds which covered their ruins. In the course of time, similar mounds would cover the ruins of Peking. It was a remarkable thing that in a country where antiquity was so much valued there were hardly any really ancient buildings; but the whole construction of Chinese buildings as a rule tempted decay. The Chinese architect began with the roof which was supported on wooden pillars. These were not set in the ground as one would expect, but merely rested on stone bases. The walls were afterwards filled in, but there was no element of stability about them, and consequently the buildings soon decayed and fell to pieces. This result must inevitably take place at no distant date in the case of the existing buildings of Peking.

The vote of thanks having been passed unanimously,

Mr. CHILD said he had not attempted to give a history of Peking, for which there was no time, but merely to give some idea of what the city was like at the present time.

Sir THOMAS WADE, G.C.M.G., writes, with respect to the height of buildings in Peking (see p. 211, col. 1, par. 3), "no roof must be higher than the palace roof;" and referring to the statement as to the overflow of the people into other countries (p. 215, col. 1, par. 1), he remarks that, "as yet, however the emigrants are less than one per cent."

Notes on Books.

COMMERCIAL HANDBOOK OF TYPE-WRITING. By W. A. Parkyn. Second Edition. London: Sir Isaac Pitman and Sons. 1894.

The more important part of this book consists of a series of exercises, graduated from simple exercises in fingering to elaborately-spaced and displayed financial statements and legal documents. These are all printed in imitation of type-writing.

These exercises are prefaced by some pages of instructions, amongst which are included rules for

spelling and hints on the routine of clerical office work.

Tables and Directions for the Qualitative Chemical Analysis of Moderately Complex Mixtures of Salts. By M. M. Pattison Muir, M.A. London: Longmans. 1895.

The title of this little work sufficiently explains its object and its contents. It is intended for the use of students who are acquainted with the principles of qualitative analysis, and have acquired a certain familiarity with the simpler processes of ordinary chemical analysis.

The tables given seem to be very complete and well arranged. The instructions are brief and clear, and, on the whole, the little manual ought to serve its purpose, and be found practically useful in the laboratory.

The Teachers' Manual of Lessons in Elementary Science. By H. Major, B.A., B.Sc. London: Blackie and Son.

This is a companion volume to the "Teachers' Manual of Lessons in Domestic Economy," and is compiled on the same plan and method. The subjects treated are divided into "Standards," but more material is provided than is required in any single school, so that teachers may choose those lessons which are most suitable to the requirements of different localities. The subjects taught in the earlier pages refer to the common things which come under the observation of all, and rise gradually, to the natural history, physics, and chemistry necessary for those children who have reached the 5th, 6th, and 7th Standards. The author states that a considerable portion of the lessons have been tested in a large group of schools during the last three years.

Laboratory Exercise-Book for Chemical Students. By F. Francis, F.C.S. London: Blackie and Son.

A series of tables for analysis, the information on which is to be learned by the students, with blank spaces for the filling in of results and observations.

General Notes.

Amsterdam Exhibition, 1895.—The World's Exhibition of Hotel Equipment and Travel will be held in the grounds behind the Ryksmuseum, Amsterdam, from May 1 to November 1, 1895, under the patronage of the Queen Regent of the Netherlands. The area of the grounds devoted to this International Exhibition illustrating Hotel Equipment and Travelling Facilities is 160,000 square metres; that of the buildings, 30,000 square metres. The classification will be as follows:—Group I., Architecture; II., Means of Transport; III., General Industry; IV., Food Industries; V., River and Sea Fishery; VI., Health; VII., Machinery; VIII., Lighting; IX., Industrial Arts; X., Heating; XI., Geography; XII., Complete Furniture; XIII., Means of Safety; XIV., Gardening; XV., Insurance; XVI., Miscellaneous. Charge will be made for space; forms of application can be obtained from the office of the Exhibition at Amsterdam, or from Reuter's International Agency, 25, Old Jewry, E.C.

Cairo Museum.—Information has been received from the Foreign-office respecting the proposed Egyptological Museum. The *Journal Officiel* of 14th January, 1895, announced that by virtue of Decision of Council of Ministers, dated 20th December, 1894, the composition of the Jury, charged with the examination of the projects and designs for the new Egyptological Museum at Cairo, will be as follows:—President—His Excellency the Minister of Public Works. Members—The members of the Egyptological Committee in Egypt. The six Commissioners of the Public Debt. The following four architects, who will be members of the Committee and at the same time will form the technical subcommittee charged with the study and examination of the several projects:—Monsieur Daumet, member of the French Institute and President of the Society of Architects in France; Mr. Somers Clarke, member of the Society of Architects, England; His Excellency Franz Pasha, ex-architect-in-chief to the Administration of the Wakfs; Monsieur Manescalco Bey, architect-in-chief to the Egyptian Government.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock:—

February 6.—"The Labour Question in the Colonies and Foreign Countries." By Geoffrey Drage. The Duke of Devonshire, K.G., will preside.

February 13.—"Light Railways." By W. M. Acworth. Sir Benjamin Baker, K.C.M.G., F.R.S., will preside.

February 20.—"Rule of the Road at Sea." By Admiral P. H. Colomb.

February 27.—

March 6.—"Cider." By C. W. Radcliffe Cooke, M.P. Sir George Birdwood, K.C.I.E., will preside.

March 13.—"Our Food Supply from Australasia." By E. Montague Nelson.

March 20.—"The Progress of the Abattoir System in England." By H. F. Lester, Hon. Secretary to the London Model Abattoir Society. Sir Benjamin W. Richardson, M.D., F.R.S., will preside.

MARCH 27.—"Modern Photogravure Methods." By HORACE WILMER.

APRIL 3.—"Sand Blast Processes." By JOHN J. HOLTZAPFFEL.

Papers the dates of which are not fixed :—

"The Use of Aluminium in the Separation of Metals from their Oxides." By PROFESSOR WILLIAM CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. CHARLETON, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. CROMPTON, M.I.E.E.

"Electric Lighting of Ecclesiastical Buildings." By MAJOR-GENERAL CHARLES E. WEBBER, C.B.

"Improvements in Milling Machinery." By J. HARRISON CARTER.

"Deviations of the Compass." By PROFESSOR A. W. REINOLD, F.R.S.

AFTERNOON LECTURE.

THURSDAY, MARCH 14, AT HALF-PAST FOUR.—"Art Tuition." By PROF. HUBERT HERKOMER, R.A.

INDIAN SECTION.

Thursday Afternoons, at Half-past Four o'clock :—

FEBRUARY 14.—"Village Communities in Southern India." By C. KRISHNA MENON, Lecturer on Agriculture at the Sydapet College, Madras. SIR CHARLES ARTHUR TURNER, K.C.I.E., will preside.

MARCH 28.—"Chitral and the States of the Hindu Kush." By CAPT. F. E. YOUNGHUSBAND, C.I.E.

APRIL 25.—"The Coming Railways of India, and their Prospects." By J. W. PARRY, A.M.Inst.C.E., late Executive Engineer Indian State Railways.

MAY 23.—"Punjab Irrigation: Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

The meetings of March 28, April 25, and May 23 will be held at the Society of Arts; those of January 31 and February 14 at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock :—

FEBRUARY 19.—"Paraguay." By A. F. BAILLIE, Consul in London for Paraguay. LIEUT.-GENERAL SIR ANDREW CLARKE, G.C.M.G., C.B., will preside.

MARCH 5.—"Colonies and Treaties." By SIR CHARLES M. KENNEDY, K.C.M.G., C.B.

APRIL 2.—"Commercial Education in Belgium." By PROFESSOR WILLIAM LAYTON.

APRIL 30.—"Madagascar." By CAPTAIN S. PASFIELD OLIVER.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

FEBRUARY 5.—"Drawing for Process Reproduction." By GLEESON WHITE. LEWIS FOREMAN DAY will preside.

FEBRUARY 26.—"Mediæval Embroidery." By MRS. MAY MORRIS SPARLING.

MARCH 19.—"Carpet Designing." By ALEXANDER MILLAR. J. HUNGERFORD POLLEN will preside.

APRIL 23.—"Art of Casting Bronze and Copper in Japan." By WILLIAM GOWLAND. PROF. W. C. ROBERTS-AUSTEN, C.B., F.R.S., will preside.

MAY 7.—"Recent Improvements in Designing, Colouring, and Manufacture of British Silk." By THOMAS WARDLE.

MAY 28.—"The Decoration of St. Paul's." By PROF. W. B. RICHMOND, A.R.A.

CANTOR LECTURES.

Monday Afternoons, at Four o'clock :—

ALAN S. COLE, "Means for verifying Ancient Embroideries and Laces." Three Lectures.

FEBRUARY 11. — LECTURE I. — Sources from which may be taken indications of ornament in textiles ascribed to Egyptians, Assyrians, and other kindred Oriental people—Actual embroideries from 1000 B.C.—Distinction between embroideries and weavings—Three broad classes of embroidery, and the antiquity of them—Climate as affecting the use of materials—Linen and wool chiefly used by Egyptians, Assyrians, and Greeks—The darning or inweaving method of embroidery predominant with them—Its development later as a weaving process—Gold thread employed with coloured threads in the darning embroideries—Examples of ornamented textiles from early Egyptian paintings—Patchwork a notable method with Egyptians and Assyrians—Examples of Assyrian and Persian embroideries.

FEBRUARY 18.—LECTURE II.—Types of Assyrian and Greek textile ornaments compared—Homer's references to ornamental textiles—Grecian women and embroidery—Lighter kinds of embroidery produced by Greeks than by Egyptians, Assyrians, and Persians—Examples of textile ornaments taken from Greek vases of Sixth Century B.C.—Varieties of embroideries taken from Græco-Scythic tombs of Third and Fourth Centuries B.C.—Fresh varieties of ornament displayed in actual specimens of Egypto-Greek, Egypto-Roman, and Saracenic work—Saracenic and Byzantine specimens (about Eighth or Ninth Century A.D.) of silk and linen work—Early Christian emblems in embroideries.

FEBRUARY 25. — LECTURE III. — Lace — Its development from twisting, plaiting, and looping threads together into ornament—Early instances of simple nets for useful purposes only (Assyrian and

Egypto-Roman)—Absence of suggestions of lace until about Sixteenth Century A.D. — Gradual changes in the texture and dimensions of laces from Sixteenth to Eighteenth Centuries—Specimens of the different sorts compared with laces, indicated in portraits.

*** Mr. Cole's lectures will be delivered in the afternoon, at Four o'clock.

DR. D. MORRIS, C.M.G., "Commercial Fibres." Three Lectures.
March 18, 25, April 1.

JAMES DOUGLAS, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures.
April 22, 29, May 6, 13.

ERNEST HART, D.C.L., "Japanese Art Industries." Two Lectures.
May, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 4 ... Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Palace Hotel, Victoria-street, S.W., 7½ p.m. Inaugural Address by the President, Mr. W. G. Peirce.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. Lewis T. Wright, "Some Matters of Interest in the Manufacture of Coal Gas."

Imperial Institute, South Kensington, S.W., 8½ p.m. Prof. F. E. Hulme, "The Flags of the British Empire, Past and Present."

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned Discussion on the paper by Mr. H. Blackburn, "The London Building Act, 1894."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Lecture on "Insect Anatomy."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Seymour Lucas, "The Evolution of an Historical Picture."

TUESDAY, FEB. 5 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Gleeson White, "Drawing for Process Reproduction."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "Internal Framework of Plants and Animals." (Lecture IV.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. J. Castell-Evans, "Physics and Chemistry." (Lecture II.—Natural Forces.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. E. A. Goeldi, "Contributions to the Knowledge of the Breeding-habits of some Tree-Frogs (*Hylidæ*) of the Serra dos Orgaos." 2. Mr. Edgar A. Smith, "A Collection of Land Shells from Sarawak, British North Borneo, Palawan, and other neighbouring islands." 3. Mr. Oldfield Thomas, "The long-lost *Putorius africanus*, Desm., and its occurrence in Malta." 4. Mr. F. E. Beddard, "The Visceral Anatomy of *Dendrolagus bennettii*."

WEDNESDAY, FEB. 6 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Geoffrey Drage, "The Labour Question in the Colonies and Foreign Countries."

Geological, Burlington-house, W., 8 p.m.

Cymmrodorion, 27, Chancery-lane, W.C., 8 p.m. Prof. Rhys, "The Story of Twrch Trwyth."

Entomological, 11, Chandos-street, W., 8 p.m. 1. Mr. G. F. Hampson, "Descriptions of New *Heterocera* from India." 2. Mr. Martin Jacoby, "Contributions to our Knowledge of African *Phytophagous Coleoptera*." 3. Prof. L. C. Miall, and Mr. N. Walker; with a Biographical and Critical Appendix by Baron Osten-Sacken, "The Life History of *Pericoma canescens Psychodidæ*."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, FEB. 7...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. H. M. Bernard, "The Comparative Morphology of the *Galeodidæ*." 2. Mr. E. M. Holmes, "New Marine *Algæ* from Japan,"

Chemical, Burlington-house, W., 8 p.m. 1. Mr. A. P. Laurie, "The Electromotive Force of an Iodine Cell." 2. Dr. Collie, "The Action of Heat on Ethylic B-amidocrotonate." 3. Prof. Haga, "The Acidimetry of Hydrofluoric Acid."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. A. Gordon Salamon, "The Germination of Barley."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. S. Lilly, "George Eliot, the Humourist, as Poet."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Commander C. E. Gladstone, "Old Touraine."

FRIDAY, FEB. 8.—Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. G. Sims Woodhead, "The Anti-Toxin Treatment of Diphtheria."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. Castell-Evans, "Physics and Chemistry." Lecture III.—"The Atmosphere: its Physical Properties."

Astronomical, Burlington-house, 3 p.m. Annual Meeting.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Annual Meeting. 2. Mr. W. B. Croft, "An Exhibition of Simple Apparatus." Mr. S. Skinner, "The Tin Chromic Chloride Cell."

SATURDAY, FEB. 9...Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander Campbell Mackenzie, "Hansel and Gretel," an opera by E. Humperdinck. (With Musical Illustrations.)

CORRECTION.—Mr. G. W. Christison writes that the date of publication of Colonel Money's "Prize Essay on Tea," is 1872, and not 1862, as printed on page 203, col. 1, line 42. He adds that the book was fully revised down to 1874, and was for years considered the authority on the subject, although it is now out of date.

Journal of the Society of Arts.

No. 2,203. Vol. XLIII.

FRIDAY, FEBRUARY 8, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

The course of Cantor Lectures on "Means for verifying Ancient Embroideries and Laces" to be commenced by Mr. ALAN S. COLE on Monday next, 11th instant, will be given in the afternoon at 4 p.m.

INDIAN SECTION.

Thursday, January 31, 1895; Major-General Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., in the chair.

The paper by Mr. S. E. J. CLARKE, of Calcutta, on "India and its Women," was read by Sir ALEXANDER WILSON at the Imperial Institute.

The paper and discussion will be printed in the next number of the *Journal.*

APPLIED ART SECTION.

Tuesday, February 5, 1895, LEWIS FOREMAN DAY in the chair. The paper read was "Drawing for Process Reproduction," by GLEESON WHITE.

The paper and discussion will be printed in the next number of the *Journal.*

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, January 22, 1895; EDWARD CUNLIFFE-OWEN, C.M.G., in the chair.

The paper read was—

RUSSIAN ARMENIA AND THE PROSPECTS FOR BRITISH TRADE THEREIN.

By Dr. Anatolius Vladimirovich Markoff.

Public feeling has been aroused lately not only in England, but also on the Continent with regard to certain reported atrocities in Armenia. It is easy to allege, but it is often difficult to prove an assertion; and therefore it is that all Europe is anxiously awaiting at the present time for the result of the labours of the Commission of enquiry. In view of this fact, it may perhaps be of interest to the public to obtain some knowledge of the life, customs, and habits of the Armenians, as well as of the country in which they dwell. The name Armenia usually applied here to all that country inhabited by Armenians is in reality *non est.* There is no Armenia to-day, any more than there is a Poland: both are extinct, although Armenians and Poles still survive the death of their country. The Armenian people are found scattered over Asia Minor and Kurdistan in Turkey; over Aderbijan in Persia, and over the provinces of Erivan in Russia. The conditions under which this people exist are nearly the same in all three countries, only that in Russia the Armenians are admitted to the rights of citizenship and their property, lives, and that which is dearest to them—their wives and children are therefore protected.

This is unfortunately not so in the two other countries where they are completely within the grasp of their officials, a class of people who are gifted with unusually horny hands and remarkable abilities for "squeezing." I myself have always felt a very great interest in the Armenians, if only as the degenerate descendants of a once splendid nation, and in my travels from village to village in the Russian part of Armenia, I have spared no pains to learn as much as possible regarding them. Having been honoured by a request from the Committee of the Society of Arts that I should read a paper on Armenia I take the opportunity of addressing you, and only beg that you will not be too severely critical on my latest acquisition—I mean the English language.

There are two rivers flowing to the south of the Caucasus—the Kura and the Araxes—and between them stretches a vast plateau, having an elevation above sea-level of about 4,000 feet. From this plateau rise the mountains of Ararat and Alagöz, both extinct volcanoes. The country embraced by these

two rivers is the Armenia of former times, the birthplace of the Armenian nation, and which, at the present time, is known as the province of Erivan. This country once played a great role in history. In it are several towns of great antiquarian interest; for instance, there is Nakhichevan, which the Armenians claim to have been the first town built after the Deluge. There is Aguri, where the patriarch Noah, after leaving the Ark, is said to have planted the vine; there is the town of Erivan, which is claimed by the Armenians as being the spot first sighted by Noah from the Ark. There is also Marant, which is considered to be the burial place of Noah's wife. The "cormorant, devouring time"—to use an expression of Shakespeare—has been, in a sense, merciful to this people: the Armenian of thousands of years ago is practically the Armenian of to-day; and the Armenian still lives on his native soil. As a rich and fertile region, it has, over and over again, excited the cupidity of foreign rulers, who have overrun and conquered the land; but the nation still survives. Moses of Chorene, the first Armenian historian, writes that "Shirak (Armenia) was a country wherein a man could find everything he wanted." Lazarus Parbetsi, an Armenian author of the 5th century, writes that "Armenia was a country where every necessity for life and enjoyment could be found; the sweetest wines, as well as the greatest pleasures."

To-day, this country, formerly so prosperous and so beautiful, is a land of ruins. Wherever the eye turns, it rests on relics of former splendour. Everywhere are ruins—of churches, wonderful in their structure and architecture; and of tombs, mostly bearing inscriptions in the ancient Armenian characters, still undeciphered. The rocks round the Gokcha lake, or the Sevanga, abound in cuneiform inscriptions, and there are also many prehistoric caves. Flint arrowheads and diorite hammers are scattered everywhere. When Egypt and Assyria are finally and thoroughly explored, archæologists will doubtless direct their researches towards Armenia. How beautiful, indeed, are the ruins of the ancient Armenian capitals on the river Arpachai, especially in Ani, Dvin, Artashat, Vagarshapat, and Erovantashat. If only some scheme could be set on foot for starting a series of scientific explorations in Armenia it would be of immense benefit to archæology. Unfortunately, scientific excavations are not viewed favourably in Russia, and even our own *kurgans*, or mounds, whose origin remains buried in antiquity—like the ancient cromlechs of Stonehenge—awaken no interest whatever. Perhaps the day is not far distant when Englishmen, with that love of science which seems inherent in the race, will take Armenia in hand, and my only hope is that it will be soon, for every day sees something valuable destroyed by the ignorant natives. To reach this country is a very easy matter. From Batum, by Tiflis, to Akstafa there is the Transcaucasian Railway, which offers every facility and comfort to travellers. The carriages are especially constructed for long journeys, and the stations are provided with excellent buffets, where all kinds of refreshments can be obtained, both cheap and good. Mr. Harry de Windt, in his work, "Across Siberia," draws attention to this special feature of Russian railway systems—the refreshment bar; and draws an amusing comparison between English and Russian buffets, to the disadvantage of the former.

The most important station between Tiflis and Baku is Akstafa, as it opens up direct communication on one side with Erivan, Julfa, and Persia; and on the other side with Alexandropol and Kars. From Akstafa, the great road to Persia begins. This town is a great commercial centre, as it is here that all the forwarding agents, and carriers doing business with Persia and the south of Russia, have their offices. From Akstafa it is necessary to take post-horses, and that kind of springless cart known as *perekladnaya*; or, if money is no object, and the extra expense can be afforded, a carriage on springs can be engaged. If, however, the aim of the traveller is to avoid delays, it is far better to go on horseback, as I did, though, even then, if you trust to the postmaster for your horse, you may not be able to get on as speedily as you would wish. The reason for this is that there are always a great many people travelling on this road, and the postmasters are not able to provide a sufficient number of horses. I was fortunate enough to have my own horse and used an English saddle, which I can recommend, from experience, as being the best. I took as little luggage as possible with me, and only included therein such things as were strictly necessary, and could be put into a *khurjin*, a native saddle-bag. My dress was that of a Circassian, a grey *arkhaluk*, by far the best dress for travelling in the Caucasus, as one always looks decent in it, whilst a European dress is quite spoilt and dirty in three days.

On a hot morning in June, 1892, I started on my ride from Tiflis to Armenia. The country was picturesque, though somewhat rough, but I pressed forward with all speed, and reached Akstafa towards sunset. As I neared the end of my first stage, I overtook several camel caravans bearing cotton from Erivan, most of which would be bought up in the town for the English market; and the shrill jingle of camel-bells sounding against the deep roar of the River Akstafa, which here rushes madly over numerous cataracts, mingled together, is a very agreeable harmony. Akstafa is built on a plain, having the Ardagh mountains, which commence about nine miles off, in perspective. The river runs through the town. Here I rested awhile. On leaving Akstafa the road rises steeply, and keeping either to the left or right of the river, crosses the mountains. The river also cleaves its way through, rushing between precipitous chalk cliffs, covered with thick and beautiful forests, till the eye is enchanted with the magnificent panorama unrolled before it. But it is after passing Kasakh—ill-famed on account of its robbers—that the most beautiful views commence. Rich Tartar villages, with their large vineyards and orchards, growing walnuts, melons, peaches, and apricots, can be seen dotted here and there in the distance. At length I reached the Tartar village *Karavanserai*, a very filthy place, but most picturesquely situated.

The road here runs through the savagely beautiful pass of Delijan. The steep mountains are clothed from base to summit with vegetation. Hazel, blackthorn, and other underwood flourish on both sides of the valley, and numerous mountain streams rush over beautiful cataracts on their way to swell the torrent of the Akstafa.

After crossing the ridge of the Dalidagh, I reached Ryedkin, a village famous for its ancient tombs. From thence, always following the road, which here descends and cuts through a splendid valley, I traversed the most thickly-wooded forests in Transcaucasia. This is Delijan, a strategic point of great importance, and famous as a sanatorium.

The road here branches into two—that on the right leading to Alexandropol and Kars, that on the left to Erivan and Persia. I took the latter, and soon found myself again rising into higher altitudes, the road creeping upwards in and out by zig-zags. The higher I mounted, the more sparse did the forest-growth become, till even the hard pine trees gave way and only Alpine vegetation was left. I passed many Tartar summer encampments, called *yailag*; the women in scarlet robes preparing the evening meal, and the men, aided by ferocious-looking dogs, guarding their flocks of sheep, goats, and oxen.

After passing the crest of the Kiomiorlu, I descended into a valley where Russian Molokany have founded a village called Syemionovka. These people, in consequence of their professing a religious creed very similar to that held by the Stundists, were, in 1840, banished to Armenia, and have settled down there.

From this village, which stands on the borders of Armenia, to the wonderful Gokcha lake—called by the Armenians *Sevanga* (blue eyes), on account of the wonderfully clear blue tint of its waters—is a matter of about five miles. This lake is truly marvellous in its beauty. High mountains, with summits peaked with eternal snows, guard its shores, and the view, seen as I saw it, with all the prismatic splendours of a morning sun reflected on its clear, unruffled waters, was one never to be forgotten. The lake stands 6,370 feet above sea-level, and in size is more than twice as large as the lake of Geneva. And the wonderful beauty of this lake is not its only feature. As if to combine beauty and usefulness—dual gifts of nature which are, nevertheless, too seldom found together—the Gokcha lake is famed throughout Transcaucasia for its fishes. The best trout in the world are caught here, called *yabani*, *ishkhan*, and *beglu*. These fish are best in autumn, and are generally dried or kept frozen for Christmas, when they are to be found on the table of every Armenian.

My acquaintance with the first Armenian village on the route, Chubukhly, which stands on the shore of the lake, was made in a singular way. I suddenly found myself right in the middle of it, before I was aware that I was in a village at all. The reason for this is, that the houses are built three parts underground, and have flat roofs covered with clay or earth. Only huge pyramids of cow-dung, which is used as fuel, and ricks of hay exist as evidences of human habitation. No trees, and no vegetation; only dirty streets, through which prowl dogs whose manners certainly did not invite any friendly advances on my part. The next village to Chubukhly is Yelenovka, the richest village in the province inhabited by Russian sectarians. These riches have been accumulated through the transporting

of goods from Zulfa to Akstafa. Leaving Yelenovka, I passed successively the village of Ordakliu—where flint arrows and obsidian swords have been found—and Agzibir, till I reached the famous monastery Airivank, a place of pilgrimage for all classes of Armenians. This stands on the shores of the Gokcha, and, as the water, although very deep here, is exceedingly clear, the dome of an ancient church can be seen quite distinctly as it reposes in the unexplored depths of the lake.

From here I continued my journey on to Novo Bayazet, the capital of the district, which is traversed by a beautiful river, the Kiavarchai, also famed for its trout.

By easy stages, I thus went round the Gokcha, on the shores of which I found many cuniform inscriptions, ruins of churches and former towns. After crossing the Karaarkhach—10,000 feet high—I reached Sherdjaloo or Nadyeshdino, a Russian village, the inhabitants of which gain their livelihood by fishing. Here, in a small boat, with my horse, I crossed the Gokcha Lake, and landed on the opposite shore at Noraduz, which must have been in former times quite a large town, as there are about fifteen churches, most of them now in ruins. Along the Kiavarchai I reached Novobayazet and thence returned to Yelenovka, taking a short route over the Kazildagh.

From Yelenovka, I went along the Zanga, which is a river flowing out of the Gokcha, to Chirchir, where there are some magnificent cataracts.

Passing over Randamal, famous for its water, I arrived at Darachichag, viz., the valley of flowers, which is the fashionable summer resort of the inhabitants of Erivan. I found it a really charming spot. The beautiful gardens, brilliant with flowers, the well-wooded forests and mineral-wells round about, the the picturesque Zanga river, flowing down between its rocky banks, all combine to render this place a lovely and a favourite sanatorium. The town is also of interest to the antiquarian, as in it are three of the most wonderful and best preserved old churches in Armenia. As I viewed these ancient monuments, still standing there as witnesses to the once wonderful art culture of "Armenia's sons;" and as I looked round on their degenerate descendants, the words of the Psalmist ran through my mind, and I thought, "How are the mighty fallen!"

Leaving Darachichag, I passed through Akhta, where there is a station of the Indo European Telegraph Company—a marvel of English enterprise—and arrived at Kanakir, which deserves special mention on account of the magnificent view which unrolled itself before me. In the back ground rose the majestic Ararat with its cloud enwrapped girdle; and immediately below, in the midst of a desert, stood that charming oasis, Erivan! But most of all did the white crest of the Great Ararat impress me with its solemn splendour. This wonderful peak seems to frown alike on Jew and Kurd, Tartar and Circassian, Turk and Russian, as if in philosophical disdain of all their party bickerings. To the left of the Great Ararat rose the pointed peak of the Little Ararat. A little later on, I made the ascent of the Great Ararat, and I have had some rather amusing experiences on account of this. It is a fact that many people in Armenia appeared quite incredulous as to my having "really been to the top of Mount Ararat," because I had brought no relics of the Ark away with me. And quite recently, in London, a lady put the question to me, whether I had found any trace of the Ark there. Not wishing to disappoint her, I replied, in all seriousness, that I had seen there a huge mass of ice having the shape of a ship, and that naturally this must be the Ark. The fearful cold there prevented me from visiting this sacred relic of the deluge. The lady appeared perfectly satisfied with my reply, and I had the satisfaction of knowing that she had experienced one pang of disappointment less in life. On this score I am hoping that my sin will be pardoned me.

Continuing my journey, I reached Erivan the next day, and found the town almost empty, on account of the great heat; and also, worse still, that cholera was raging violently there.

Although the oasis of Erivan, with its rich growths of semi-tropical vegetation, has such a beautiful aspect, when viewed from afar, like many other apparently beautiful things, a nearer acquaintance quite dispels the allusion. The town is filthy in the extreme, with that disregard, moreover, of the primary laws of sanitation which seems peculiar to Oriental peoples; the contrast between the pestilential, oven-hot atmosphere of the town and the exquisitely pure, keen, air I had been lately breathing, was painfully marked.

As I roamed the reeking streets, my lungs seemed to refuse to inhale the disease-laden air, and my breath came and went in sharp, quick gusts. I did not stop here any longer than

I could help, but pushed forward to Davalu, going from thence to Nakhichevan and Julfa, on the Persian frontier, Ordubad, and returning through the districts of Sharur and Daralagöz to Erivan, where I started for the Alagöz, the ruins of Ani and Alexandropol.

And now, as time is pressing on, I will try to lay before you the pith of my discourse in some brief, general remarks on Russian Armenia and its inhabitants.

In this, comparatively speaking small place, exist, almost side by side, the most diverse materials for a study of Oriental sociology. The greatest contrasts in tribes, languages, religions, customs, and culture are jumbled together, seemingly pell-mell.

The inhabitants are, generally speaking, prosperous, and the principal sources of this prosperity lie in agriculture, although nomadic tribes, with their flocks, are found side by side with these "tillers of the soil." In agriculture lies the country's principal source of well-being.

The question of greatest importance here is that of irrigation. Where there is water there is prosperity.

No one can doubt, however, but that the wealth of this country is steadily diminishing every year. The old canals are allowed to go to rack and ruin, unrepaired and uncared for; whilst the new system of irrigation, introduced by the Government, is carried out, as usual, on the very worst principles.

And now, as regards the population, the greatest part consists of Armenians, who number about 800,000. Endowed with natural gifts—intelligence, and a special aptitude for commerce—this race also allies to these perseverance, active zeal, and love of enterprise, so that it is no wonder they flourish wherever they set foot. It is a fact that the whole trade of Tiflis, the capital of Transcaucasia, rests already in the hands of Armenians. And not only do they excel in commerce. They gain admittance to Russian schools and universities, receiving there all qualifications necessary for Government officialdom, and afterwards they crowd into the Government service. All over the Russian Empire Armenians can be found exercising the highest Government functions; for instance, the Minister for Public Education in Russia, Count Delyanoff, is an Armenian.

In the province of Erivan, the Armenians, both men and women, lead a very industrious life. The men work in the fields, and the women at home. In the spring every male fit for work goes out, without exception; the older ones plough, and the children drive the oxen and buffaloes. During harvest time every person able to work, both male and female, are in the fields. The older people wield the scythe and sickle, while the younger work with rakes. I regret very much that time will not permit me to go more into detail on this interesting subject. I must content myself with saying that it is my hope to have some articles ready shortly dealing especially with the life, manners, and very interesting superstitions of the Armenians. I will, therefore, now pass to the main question—the development of trade in this province. As a preliminary, I may mention that I hope a railway, connecting Akstafa with Delijan, Erivan, and Alexandropol, will shortly be under construction, and will thus afford every facility for a commercial opening up of this rich country. At present the places about which I speak can be reached by means of the great post and military roads, which are all maintained in very good condition.

First of all, to deal with the mountains of Satanakhach, Ogruja, Bolshoij - Karaklis, Keity, Kara-Arkhach, Kiomorlu, &c. These mountains, especially the first two, lying on the eastern shores of the Gokcha Lake, are rich in different ores, and I discovered many traces of coal; but the seams are unopened and unworked. The value and uses of coal are entirely unknown in this region—a fact which sounds strange to you, but which is quite true. Wood and dried cow-dung form the sole articles of fuel, and even these in most parts are only to be obtained by the natives at exorbitant prices. If the uses and benefits of coal as article of fuel could only be demonstrated to the ignorant inhabitants, then there would be a vast field for commercial enterprise opened here. As it is, this country—real, natural storehouse as it is of mineral and metallic ores, teeming in buried wealth—remains closed and lost to humanity. I may mention that throughout my travels in Russian Armenia, I carried my own maps and carefully marked thereon all places where I discovered traces of gold, silver, copper, lead, mineral waters or coals. This information I did not communicate to the Government—indeed, it was not necessary, as it is very seldom that a European is seen here at all, and the village elders in many places told me that I was the first Russian who had been in that place.

Then, as regards mining. The only mines in Transcaucasia are those belonging to the great firm of Siemens in Kedabeck—working copper. It is a matter of wide repute what immense profits this firm clear from these mines. Great metallurgical works could also be founded in other parts, and, with coal near at hand and labour very cheap, great facilities are offered for these being worked effectively.

Then the use of steam-machinery in the province is almost entirely unknown. For instance, there is not one single steam flour-mill there. The whole of the corn is ground by means of thousands of portable water-mills, worked in the most primitive manner. Wishing to satisfy myself as regards the latter, I asked an Armenian for permission to inspect one of those mills, when, to my great surprise, he told me that I need not take so much trouble, as he would bring it to me. I thought this was very obliging. Evidently it was a case of Mahommed not needing to go to the mountain, as the mountain could be brought to Mahommed. My curiosity was very much excited by these portable mills, but when I saw what he meant, alas, what a fall was there! My obliging friend brought me just two millstones, one over the other—that was all! It was something like the primitive hand-mill, the only difference being that it was adapted for water-power, instead of hand-power.

This Armenian was fortunate enough to possess his own mill, but there are many who are not so lucky, and these have to pay a terribly high price for grinding their produce—one-half of the grain! Here is, indeed, a splendid opening for British enterprise in the establishment of steam mills. Wonderful profits could be certainly gathered in by this means, as labour costs next to nothing, that is to say, one shilling a day, out of which the workman has to provide his own food.

I have every reason to believe that the cultivation of cotton, tobacco, rice, and fruit, would also pay very well, especially the cultivation of cotton. A few enterprising Englishmen have already established themselves in Erivan, and if these make a profitable livelihood, I do not for a moment doubt but that other Englishmen would also prosper there.

The culture of the grape and the growing of fruits have become very important items, since France and Spain have developed their wine industries so largely. Great quantities of wine are yearly exported to these countries, where, after blending with wines of native growth, they are shipped off to England as *bonâ-fide* French or Spanish wines. I do not see any reason why Englishmen should not buy the wine first-hand, the more so, as an extensive trade is done there even now in Manchester and Birmingham goods, bought by the Armenians in England and resold. If Armenians do this, what is to prevent the English monopolising this trade, taking in exchange the products of Armenia—especially hides, rugs, carpets, wool, and cotton. English merchants do not generally allow themselves to be forestalled in commerce, but Armenia is an exception to the rule. There are many German and French firms who do a splendid trade there, but very few English indeed.

Then again, Armenia, on account of its rich Alpine pastures, could be easily made the Switzerland of surrounding countries, for cheese and other dairy products. Only recently experimental trials have been made by Germans to introduce Swiss or Dutch cattle into the country with a view to the production of butter and cheese. These trials have been most successful, so here is yet another opening. But not only in Armenia; in the whole Caucasus are almost countless openings for British enterprise standing ready at hand, and I think there is an English proverb which says: "First come, first served." It is so in this case; the trade is waiting patiently for Englishmen to come and take it, and if the English do not come, other nations will. France at the present time is buying very large quantities of raw silk from the Caucasus; why cannot the English cultivate this industry? You must pardon my saying so, but it seems to me that English enterprise of to-day, so far as her commerce is concerned, is settling down into certain well-defined grooves, for that which she does not know she does not seem to care to know. How different is this state of things to that existing in the "Merrie England" of 350 years ago—the days of the "Russia" and of the "East India" Companies.

In 1552 three gallant English ships set sail for the purpose of trying to find a new way to China and India by the Arctic Sea. A storm separated the vessels off the coast of Lapland, and two of them were gripped in the ice floes and frozen in. They were discovered by Lapland fishermen, every member of the two crews dead, and the leader of the expedition, Captain Willoughby, with them. When found, this brave captain was sitting in his cabin with head bent down over his diary.

The third vessel, with Captain Chensler, succeeded in entering the White Sea, and she landed her crew at the mouth of the Dvina river, where in former times stood the monastery of St. Nicolas, and where afterwards the city of Archangelok was founded.

These were the days when England did not wait to have openings for her commerce pointed out to her. She boldly set forth unaided, and discovered them for herself.

And now I beg to crave your indulgence for a few words on the great similarity of English and Russian aims and interests, not only in Armenia, but also throughout the vast East. I need not tell you that Russia, at the present time and under the guidance of our brave young Tsar, stands on the threshold of a more liberal and enlightened policy, not only in economic and religious matters, but also in her international relations. Education has made great strides in Russia during the last 30 years, and is still going on her forward course. A more enlightened generation is springing up, and trade and industries will therefore develop mightily. This will be especially the case now that the Ministry of Finance has been entrusted to such an able man as De Witte, whose sole aims and wishes are to develop trade to its uttermost. England should take advantage of this, and the conditions are altogether favourable at present for her doing so.

Their Royal Highnesses the Prince and the Princess of Wales, by their late visit to Russia —when they acted as messengers, bearing the honest sympathy of the British people to Russia in her affliction—have been, as it were, the pioneers of the way; and I hope that there will speedily come that recognition of brotherly aims and kindred sympathies which should unite English and Russian peoples in bonds of friendship. The whole Russian nation has been moved at the sight of these illustrious relatives of their much-beloved Tsar, treading their soil in amity and sympathy; and before the year comes to an end, the portraits of the Prince and Princess of Wales will be found in the home of every peasant throughout the Russian Empire. Every Russian has felt that only friends could so stand in sympathy beside their much-beloved Emperor; and every Englishman visiting Russia now, will be looked upon as a friend beforehand, and will be received with open arms accordingly. Russia only waits for England to respond, to clasp hands, and the brotherly compact will be sealed.

Both countries have the same aims—the civilisation of the uncivilised. And what a splendid sight it would be to see England and Russia hand in hand in the march of progress, united, by striving to give peace and bestow the blessings of civilisation on Asia.

DISCUSSION.

Mr. WALLACH said that he had visited the country in 1889. He had very little to add as to the condition of the people and to the general description given in the very interesting paper just heard. But with regard to the question of bringing Armenia within the reach of and into connection with British trade and enterprise, he might be able to add some remarks. Armenia had been split up into three parts, and its subjects were ruled respectively by Russia, Persia, and Turkey. The paper to-night confines itself exclusively to Russian Armenia. However, the greater part of the Armenians are under the sway of Turkey. Persia is prolific in natural products, and disposes, not to an inconsiderable extent, of manufactured goods, and the main artery of its trade is the rough road through Armenia. The English proverb, "Time is money," is quite unknown in the East. A Persian, in order to save a kran, would rather prefer the slowly moving camel caravan *viâ* Erzeroum and Trapezond than take advantage of the existing communication across the Trans-Caucasian Railway to Batoum, get quickly to the Black Sea, and thus ship the goods to England. A very considerable quantity of Manchester goods is used in Persia, and if the Turkish Government could be induced to develop facilitated communication with Trapezond, the most important Turkish port in the Black Sea, and if English engineers and capitalists should see their way to connect Erzeroum, the capital of Armenia, with Trapezond, a distance of rather less than 300 English miles, by means of a railway, not a difficult engineering feat, this line, once built and possibly further extended, would give an impetus to trade, and traffic might be very considerably increased to the benefit of all concerned. The country is in certain districts very rich in cattle, also in goats, sheep, &c., and some of the main articles of export in those regions are hides, the principal demand for which, he believed, was in America. But the people do not know how to prepare the skins and hides, and, from the length of transit, they very often deteriorate in quality, and consequently also in value. He noticed with great satisfaction that politics had purposely been avoided in this paper just heard, and, although unwilling to touch this burning question, so much discussed in our daily papers, and without going into the details of the causes of the political questions, he might, however, be permitted this one observation, viz., that people ought not to believe all they read. When, in 1889, on his ride through the country, unattended and absolutely alone, and dependent on his own strength and resources; and notwithstanding the fact that there was then also an insurrection brew-

ing, he was—barring little incidents—never molested by anybody, and he was always better received by the Armenians than by the Kurds or others. The Armenians are proud of their country. A nation with such a glorious history and traditions, and which once played a most prominent part in spreading learning and civilisation, is anxious to develop on their own lines. The most capable Turkish officers in the service of the Government of H.I.M. the Sultan and in the administration of the country are Armenians, and many also occupy high public positions in Russia. He believed most of their misfortunes were due to the misrule of Pashas, unknown to and not sanctioned by the Sultan. Without, however, glorifying the standard of morals of the present generation, and taking into account the general disposition of Eastern people, which to a specific extent they share in common with their more civilised Western brethren, viz., a general dislike to pay taxes. This sore point is often the cause of a grievance, developing into quarrel, culminating finally in open rebellion. He hoped soon to revisit those regions and see what was the real position of affairs.

Mr. H. F. B. LYNCH said all who had travelled in the country which had been so graphically described, as well as the much larger number who were interested, especially at the present moment in the march of Asiatic affairs, would feel grateful to Dr. Markoff for the manner in which he had alluded to the friendly relations which he said were about to spring up between the Russian Empire and ourselves. If he might venture on any criticism of the paper it would be this, that the political alliance between Russia and Great Britain would be considerably prior in date to any economical understanding between the two nations in those countries in the East, where they respectively exercised commercial supremacy, viz., those between India and the Black Sea. There was no greater barrier in the world than a commercial barrier, and no frontier more firmly fixed than the commercial frontier which existed along the north of Persia and the Russian border to the Black Sea. He was surprised at Dr. Markoff's remarks as to the want of enterprise on the part of Englishmen in those countries. He could conceive an English pioneer ship entering the port of Batum, and he could fancy his friend, Baron Kluppfel, boarding that ship, inspecting every bale of merchandise, and then with the greatest courtesy, but, at the same time, the greatest firmness, forbidding any introduction of goods which would compete with the products of Moscow and other centres of Russian industry. No efforts on the part of British merchants could overcome that economic barrier. He could not blame Russia for her commercial policy, because we must recognise that in commercial matters we were rivals in the East. In Persia this commercial rivalry between Great Britain and Russia could be gauged by barometrical symptoms. At one moment you saw Russian trade pushing its way a little farther south; at another, English trade pushing itself a little farther north. Every effort was made on the part of Russia, supported by her diplomatic agents in Teheran, to thwart the forward commercial movement of England; and nothing our political relations could effect would do anything to change that rivalry, which, after all, was perhaps a healthy one. Persia was an open market, which was ready to welcome trade with Russia on the north and with England on the south; but when they crossed the Russian border, it was a totally different thing. There the customs barrier existed, and it was impossible for England to import any goods into the country. Not only that, but the economical policy of Transcaucasia was in every way subservient to the economic policy of the Russian empire at large. This had not always been the case; at one time the Governor-General of Trans-Caucasia exercised a more or less independent authority, but that no longer existed. In his recent travels through the country—where he was received in the most kindly way by all the officials, and he only hoped similar courtesy was extended to Russian travellers in India—he found from conversations with the Governors of the various provinces, that the policy now was to keep the country completely for the enterprise of Russians. The difficulties did not relate only to England, and he quite accepted the fact, but it was a question whether the Russian Government was well-advised in not only adopting an economic system which excluded the products of other nations which were her competitors, but in depriving the people of the country themselves of the means of developing their own country by their own resources. After a somewhat careful study of the subject, he came to the conclusion that the Armenians in Russia were not allowed sufficient scope to develope their own country. For instance, application had been made time after time to allow of the irrigation of lands, which were lying idle, and of the introduction of machinery by the Armenians themselves; and they had all, in one way or another, fallen through, and not through any fault of the promoters. In Teheran, on the other hand, Frenchmen, Germans, Belgians, and men of all nationalties, both capitalists and workmen, would be found, and European newspapers could be obtained. On the other hand, in Erivan there was the greatest difficulty in obtaining a European newspaper of any kind; and no foreign representative of commerce or industry was to be found. They must all hope that good would accrue to Asia from the strengthening of friendly relations between Russia and England; and he could not help thinking that, during the reign of the young Emperor, the countries west of India would enter on a far sounder and better set of conditions than had formerly prevailed, but he could not fairly reproach British merchants with any remissness in their efforts to do

business there, because all such efforts would be vain. He entirely agreed with what had been said by the last speaker with regard to the Armenian people as a whole; he believed they had a very great future, and they would probably play a most important part in the introduction of Western civilisation. He only hoped they would be left alone by rival interests to pursue their own destiny, as far as might be possible, by themselves.

Mr. WALLACH said he did not quite agree with the views of Mr. Lynch. Russia had abundant resources of her own of every kind, and if all other countries were absolutely excluded, she could exist entirely on her own products. It was more a question of trading with other parts of Armenia beyond the reach of Russian influence and customs dues. The greater part of Armenia, as said before, is under Turkish rule and some provinces under Persian. In the east the world moves rather slowly and many things and institutions remain there up to this very day exactly as described to us in the Bible. Agriculture and everything else is carried out under the most primitive conditions, and considering the snail-like pace of progress, advance should only be expected slowly but steadily, and Englishmen with their integrity and proverbial honesty, should show them how to attain it. The chief point is to bring about the introduction of such English goods as are suitable to the demands of the people to whom they are as yet unknown.

The CHAIRMAN, in proposing a vote of thanks to Dr. Markoff, said they would agree that his latest study, that of the English language, had been turned to very good account. Armenia was one of the oldest inhabited countries of the world; they had heard of its fertility and mineral wealth, and it seemed a thousand pities that some serious effort could not be made to develope its resources. In these days when it was essential for English merchants to seek new markets, it was to be hoped that their attention would be directed by this paper to Armenia, and that that country might once again rise up and become the great country she once was. With the characteristics of the Armenians, as described by Dr. Markoff, their love of enterprise and aptitude for commerce, it seemed scarcely possible that a country with so much national wealth should much longer languish in poverty. Dr. Markoff was right in some respects about British trade running in grooves, but he must remind him that even now we could strike out a new line occasionally; as a proof, he need only instance Mr. Cecil Rhodes' great speech the other day to the British South African Company, which showed there was a little of the old English blood left in us still. They were all at one in rejoicing at the good feeling which was springing up between Russia and England, which could not fail to have a vast influence for good.

The vote of thanks having been carried unanimously,

Dr. MARKOFF, in reply, said the main part of Mr. Lynch's remarks applied to the state of things formerly existing, but since the present Minister of Finance, Mr. De Witte, had taken office there was a change. In Tiflis there were many Frenchmen and Germans, but no English, and he did not see why that should be, as all foreigners were under the same conditions. Erivan was looked upon by Russia as belonging to the Persian part of Armenia, and therefore they did nothing for it. It was for that reason he drew the attention of Englishmen to the country. There was trade to be done there, whether under Persian or Russian rule, and while he had mentioned Armenia specially, he should like to draw attention to the whole of the Caucasus as offering a great field for English enterprise. Others went there and became rich, and why should not the English. If an official authority were required, application should be made to head-quarters at St. Petersburg.

NINTH ORDINARY MEETING.

Wednesday, February 6, 1895; the DUKE OF DEVONSHIRE, K.G., in the chair.

The following candidates were proposed for election as members of the Society:—

Bagnold, Major Arthur Henry, R.E., Brompton Barracks, Chatham.
Budden, Edward Russell, Camelot, Netherhall-terrace, South Hampstead, N.W.
De Salis, Henry Rodolph, Fairacres, Oxford.
Fielding, P. J. D., 8, St. Joseph's-place, Cork.
Jones, Alfred L., 14, Castle-street, Liverpool.
Porter, Horatio, M.A., 16, Russell-square, W.C.

The following candidates were balloted for and duly elected members of the Society:—

Burgess, G. Douglas, C.S.I., Judicial Commissioner, Upper Burmah, Mandalay.
Harris, Francis Eldred Lodge, 75, High-street, Chelmsford.
Hurtzig, Arthur Cameron, 2, Queen-square-place, Westminster, S.W.
Jenkins, David, Abbot's-hill, Llandilo, Carmarthenshire.
Laughlin, Robert C., Gortin, Newtownstewart, Ireland.
Lloyd, Christopher, R.E., 1, Invicta-villas, Balmoral-road, New Brompton, Kent.
Speller, James, 61, Golden-lane, E.C.
Story, William Henry, 83, Alexandra-road, South Hampstead, N.W.
Williams, Alfred Goodinch, London Institution, Finsbury-circus, E.C.

The CHAIRMAN, in introducing Mr. Drage, referred to his services as Secretary to the Labour Commission, and to the summaries and reports of the evidence which he prepared in that capacity. There was a very general agreement as to the

impartiality with which Mr. Drage performed those duties, but inasmuch as it was impossible to exclude entirely the individual opinions of the writer, they were published upon his responsibility, and not on that of the Commission. In the same way with regard to the present paper, he understood that Mr. Drage was going to deal with the labour questions in the colonies and abroad in connection with administrative, executive, and religious organisations; and as he himself had not studied the subject from these points of view, it must be understood that though he had great pleasure in presiding on this occasion, he must not be held to be committed to the opinions which were expressed.

The paper read was—

AN INTRODUCTION TO THE LABOUR QUESTION IN THE COLONIES, AMERICA, AND FOREIGN COUNTRIES.*

By Geoffrey Drage.

Outside England and English-speaking countries there scarcely exists a non-Socialist labour movement. Whatever the future may hold in store for us at home, it is certain that in the past the upward struggle of the working-classes has been marked by a sturdy self-reliance, and a trust in individual effort, which removes it far from the principles and practice of latter-day Socialism. Abroad this spirit of self-help is still far to seek. Perhaps, therefore, the American, Colonial, and Continental labour movements will not have taught the English student their least valuable lesson if he learns from them the supreme importance of holding fast to the self-governing traditions of his fathers.

I have elsewhere defined the labour question as the problem of harmonising the rights and duties of the working classes with the existing order of society. The solutions which have been advanced for the foreign labour question may be roughly divided into three classes: there have been, firstly, attempts on the part of politicians; secondly, quickened activity amongst the churches; and, thirdly, efforts, more or less intermittent, made by private individuals of various classes to further the work of social reform. In England a fourth solution would be placed first in order of importance, the work, namely, of the great associations of working men, which have done so much for the improvement of the conditions of labour; but, if we except the Colonies, and in a less degree the United States, this element in the English labour question has no counterpart save in Socialist organisations, which have scarcely yet realised, even dimly, the value of self-help.

This absence of the self-governing spirit in foreign labour politics can only be explained by the wide difference which exists between the two classes of political institutions, distinguished here for convenience sake as "English" and "Continental." Nowhere is this more marked than in the region of legal theory with its corresponding influence upon political practice. The Continental lawyer recognises a number of distinctions to which English lawyers are professedly strangers. French or German jurisprudence divides the great body of law, both public and private, into six sections. Three of these, constitutional, administrative, and criminal law, deal with public rights or the relation of the individual to the State. Of the remaining three, commercial and industrial law deal with certain classes of private rights, whilst the rest of the civil law is concerned with all such private relations as are not included in either of the two preceding sections. But this very distinction between the citizen in his individual capacity on the same footing with other individuals, and the citizen as a member of a class with special interests over and beyond the interests of the commonwealth, marks one of the most vital differences between the political institutions of England and those of the Continent.* The difference becomes especially prominent in the province of administrative law, the French *droit administratif*, which has been defined by Professor Dicey as the "portion of French law which determines the position and liability of all State officials, the civil rights and liabilities of private individuals in their dealings with officials as representative of the State, and the procedure by which these rights and liabilities are enforced."† Since labour legislation consists chiefly in an attempt to define the proper limits of State control and the degree in which

* Authorities for the Paper:—I. "Reports made by the author to the Royal Commission on Labour—Vol. 1, "The United States;" vol. 2, "The Colonies and India;" vol. 3, "Holland;" vol. 4, "Belgium;" vol. 5, "Germany;" vol. 6, "France;" vol. 7, "Switzerland;" vol. 8, "Italy;" vol. 9, "Sweden, Norway, Denmark, Spain, and Portugal;" vol. 10, "Russia;" vol. 11, "Austria, Hungary, and the Balkan States." II. Professor Holland's "Elements of Jurisprudence." III. Professor Dicey's "Law of the Constitution." IV. Professor Goodnow's "Comparative Administrative Law." V. Professor v. Gneist's, "The English Parliament."

* *Cf.* Holland, "The Elements of Jurisprudence," 1882, pp. 90-110.

† Dicey, "Law of the Constitution," p. 184.

officials are entitled to infringe upon the rights and liberties of individuals, it is sufficient here to concentrate attention upon administrative law, though it may be noticed in passing that the very phrase "labour legislation" indicates the growth of the "continental" tendency to create classes within the commonwealth with peculiar rights and interests protected by a special body of rules.

Admitting that as administration is a necessary function of government, there must be some body of rules regulating the exercise of this function, it may at the same time be pointed out with Professor Dicey that "in England, and in countries which, like the United States, derive their civilisation from English sources, the system of administrative law, and the very principles upon which it rests, are unknown."* This ignorance springs from the fact, repeatedly emphasised by Dr. von Gneist, that in England, up to the 18th century, there was, strictly speaking, no official class. The Roman tradition of proconsular or prefectoral government, by means of officers in close connection with a central authority, prevailed indeed for centuries over the Continent, but the early withdrawal of the Romans from England, and the advent of the Saxons with their old German system of self-governing communities established a tradition of administrative government in England which even the strongly centralised Norman rule was powerless to break. It is needless to trace the stages of this development. Even the officers who under Norman influence were appointed by the Crown to carry out its behests, became in later times "regarded as ordinary citizens, who for the time being were serving the Government by the discharge of public functions, and who after their time of service had expired would fall back again into the ranks of private citizens. They were not exempted in any way from the observance of the law on account of their official position. If during the period of their discharge of public functions they committed an act not justified by the law such act was regarded as an act of a purely private and personal character, for which, like any citizen, they could be held responsible before the ordinary Courts."† This responsibility held good even when the act was done in obedience to the orders of a superior. In other words, England up to the end of the 18th century recognised no official class, and the countries inheriting English institutions still adhere to the principle of non-professional service in local administration. The view taken of this service is no less important than its unprofessional character. The Justices of the Peace, who united in their own persons so many judicial and administrative functions, were, as Dr. von Gneist has said, "officers of honour . . . . uniting in one person the office of honour, the feeling of honour and duty belonging to the higher class, and the feeling of honour and duty belonging to the State functionary."* Their property qualification rendered them independent of remuneration, and their habit of looking at public questions from the civic rather than the bureaucratic point of view, helped to foster a sense of the common interest and of the obligation lying upon them to regard the public service as a social distinction.

* Dicey, "Law of the Constitution," p. 184.

† Goodnow, "Comparative Administrative Law." 1893. Vol. ii. p. 163.

On the Continent, where the Roman tradition remained paramount, there was developed the bureaucratic system, which, in one form or other, still survives. As Mr. Goodnow says: supporting his view by a reference to Dr. Loening:—"The German principle of the responsibility of officers was at first adopted on the Continent. Soon, however, with the introduction of the Roman law, came the Roman principle of official irresponsibility." One strong reason for the general adoption of the Roman rule of law is to be found, according to Mr. Goodnow, in the necessity under which "kings and princes" of Germany and France found themselves when face to face with the rights of the feudal lords. "The struggle with feudalism was at its height, and it was the private rights of the feudal lords, or what they chose to consider as their private rights, which were most liable to violation on the part of the princes of the Continent. . . . The retention of the principle of the responsibility of the royal and princely officers to the ordinary courts would therefore have effectually prevented the kings and princes from destroying the feudal system, with all its abuses and pretended vested rights, and would have made impossible the development of the national State upon the Continent. The desire of the absolute monarchy to reduce the nobility to submission, and to do away with feudalism, led therefore to the adoption on the Continent of the Roman principle that the officers of the Government might be sued

* Gneist, "The English Parliament," p. 327.

by the individual only after the consent of their superior had been obtained." The privileged official class thus created survived even the shock of the great continental upheaval at the time of the French Revolution; indeed, it emerged from its temporary downfall only to assume a still stronger position under the Code Napoleon. "The desire of the leaders of the Revolution to carry on the reform work of the monarchy was so great, and their distrust of the Courts on account of their attempts to protect the privileged classes in the latter days of the monarchy was so widespread, that little desire was felt of subjecting the administration, which was to carry on the reforms of the new era that had just dawned, to the control of the Courts." The principle that no individual could bring suit in the Courts against an administrative officer until the Council of State had given its consent remained, therefore, an integral part of French law until 1870, and aided the formation of the modern French bureaucratic system.*

The professional character of this system, as of all Continental bureaucracies, follows inevitably from the position of the officials as a privileged class or definitely-organised branch of the public service. Even the local officers in France are professional, and, for the most part, in receipt of a salary. Prussia has, since 1872, made a strenuous attempt to revive honorary and unprofessional service after the British model in local administration. The committee of the circle (*Kreis*) was an imitation of the English petty and special sessions of the peace. "One of the chief ends of the reform movement was to do away with the institution of hereditary magistracy, which existed especially in the eastern provinces of the kingdom, and under which the local police was administered by the large landholders." In order to abolish this, "almost the last relic of feudalism," and "to attract into the service of the State the well-to-do and intelligent classes," the law of 1872 was passed, and, according to Mr. Goodnow, has proved successful.† Recently, however, complaints have been heard in the agrarian districts of the burdens imposed by the insurance legislation, which threaten to render a return to professional service the inevitable outcome of a policy of "State Socialism."

* Goodnow, "Comparative Administrative Law," 1893. Vol. II., pp. 169-176.

† Goodnow, "Comparative Administrative Law," vol. i., pp. 316, 317.

The character of the Continental bureaucracy —as compared with that, for instance, of the United States—appears in the manner of appointment and of removal, and the qualifications indispensable for office, no less than in the giving or withholding of a definite salary. Both in France and Germany, the great majority of offices, central as well as local, are filled by executive appointment, a method admirably adapted for securing harmony, and possibly efficiency, in administration, but tending to perpetuate bureaucratic tradition, and to create an official caste. On the other hand, a large number of offices in the United States are elective, and, as a corollary, the qualifications required are much fewer than in the case of offices filled up by appointment. As a rule, they consist merely of "citizenship, or the right to vote, the attainment of a certain age, the possession of good character, and, for the majority of offices, the possession of the male sex."* Local officers must reside in the given locality, but real property is less often required than in Europe. For offices dependent upon appointment some test of physical and intellectual capacity is required, and the system of competitive examinations—introduced in 1870, but discontinued again in 1874—has become the rule since the passing of the Civil Service Laws in 1883. There is little stress laid, however, upon practical experience or special training, and the term of probation required is remarkably short. In France and Germany, on the contrary, special education, and a long period of probation, are of the first importance; and entrance into the ranks of the bureaucracy is as much a matter of professional preparation as the adoption of any other permanent vocation. As in the naval, military, or diplomatic services, the son frequently follows the calling of the father, and though such a practice may develop hereditary aptitude for administration, it is equally favourable to the growth of a rigid bureaucratic tradition, with its concomitant evils. In France, an early age is fixed for entrance into the service, and for positions requiring professional or technical knowledge a course at the Government schools is indispensable. The term of probation is frequently extended to two years, and may be still further prolonged. The German system of examination is so complicated as to make "office holding—especially in the highest positions—a learned profession on a par with the other

* Goodnow, "Comparative Administrative Law," vol. ii. p. 28.

well-recognised learned professions,"* and, unlike all other countries, Germany expects even the highest administrative officers to give proof of their theoretic training and aptitude for their position. Even after examination they must undergo a prolonged period of probation. It follows that tenure of office is far more permanent in France and Germany than in the United States, and that official discipline assumes an almost military strictness. The French penal code punishes all officers "who, by a preconcerted decision, resign in order to prevent or suspend the action of some public service;" whilst a German official cannot resign until his work is finished, his accounts audited, and his resignation accepted.† On the other hand, the German official is not subject to arbitrary dismissal, and cannot, as a rule, be removed before his term of office expires, except by the decision of a disciplinary tribunal, or upon conviction of a criminal offence. The American service suffers from insecurity of tenure, and the system of "rotation in office," in accordance with the politics of the party in power, has had disastrous effects upon the whole administrative system. The charge brought against the New York Commissioner of Labour of falsifying his statistics for party purposes is significant of the spirit animating too many American politicians, and raises grave doubts as to the probable incorruptibility of a bureaucracy dependent for its position upon the popular vote.

Any general estimate of the strength and weakness of bureaucratic government must, therefore, take into account both the means of control provided, the way in which this control is exercised, the character of the services, and the kind of Government under which it serves; probably the last is the least important consideration. A strong and highly organised bureaucracy can exercise as effective a tyranny under a democracy as under a despot. The multiplication of regulations, and the gradual widening of the sphere of administrative law will have precisely the same effect in diminishing private rights and restricting individual freedom, whether the encroachment be undertaken at the will of an autocrat, or merely represents another step towards the realisation of the Social Democratic "State of the future." (*Zukunftsstaat.*) Further, this danger increases in proportion to the degree of organisation attained by the bureaucracy, and its consequent efficiency, so that the character of the bureaucracy is a question of far greater weight than that of the Government controlling it. If it must be conceded that professional service with a more or less permanent tenure of office may, and often does, result in the development of highly-specialised ability, in continuity of policy and in efficient administration, it must also be remembered that multiplication of offices involves increasing charges upon the common purse, which may more than counterbalance the economy due to efficiency. Moreover, to confer most of the important administrative powers upon members of a limited profession is to deprive the general body of citizens of a training in the school of self-government which could scarcely fail to keep alive a sense of duty to the community. Again, the creation of a close bureaucracy is the addition of another and a governing class to the classes already existing, and appears a strange method of obliterating the class hatred deprecated by social reformers. I do not, of course, deny that in a complex state of society the sphere of administrative action is necessarily wide. At the same time, I do suggest that the control of that administration may find a more important function in keeping administrative activity within due bounds than in encouraging it to enlarge its borders.

The means adopted for exercising this control vary considerably in the different countries. France and the United States illustrate in their several ways the method of popular control. In the United States this control is exercised through the election of the chief executive authorities, who, in their turn, give its colour to the administration. In France, the desired result is achieved by subordinating the administration to the Legislature. Either alternative is open to serious objection. The American system induces a general sense of insecurity, and a consequent desire to propitiate the electorate; the French system has too often, and especially in recent times, led to such an abuse of its powers by the Legislature as to make the work of government almost an impossibility. "Interpellations, addresses—questions as to its policy, and censures of the action of the administration—have been so frequent, that the French acting executive has been completely terrorised and paralysed; and the control which the Legislature possesses,

* Goodnow, "Comparative Administrative Law," vol. ii., p. 57.

† *Idem*, pp. 95-100.

and which, in order that the Government may be well-conducted, should be used with moderation, it has made use of to deprive the administration of almost all discretion, and practically to concentrate in the Legislature many administrative functions." Where, as in France, the Ministry are "the servants, rather than the guides, of the Legislature," they "become naturally so anxious to win its approval, as to be unable to conduct the Government wisely."* The result of this official attitude, in its reaction upon the local authorities, appears with startling clearness in the history of the French labour movement. Whilst fear often paralyses the administration, it also results in needless severity, when action becomes inevitable. It is sufficient to notice, in passing, the recent anti-Anarchist legislation. In Germany this danger was perceived at an earlier date. The use which might be made of an administration subject to ministerial or legislative control by the political party in power, was exemplified in Prussia, between 1850-60, by the action of the Conservative party in the land-holding interest. To remedy this evil, Imperial legislation has provided for judicial control of the administration, in some instances, by the ordinary Courts, in others by special Courts as in France, but with non-professional judges, as in England. The power of the Legislature is confined to that of interpellation, but under a strong Government, like that of Germany, the moral effect of such a procedure is very much weaker than in France. If on the whole the German bureaucracy is the most powerful instrument of the kind yet created, the method of its employment is, at the same time, far less prejudicial to the interests of liberty than that of the bureaucracy controlled by the French Chamber of Deputies. It may even be held to escape some of the difficulties inherent in the American and Colonial systems of frequent change; but, on the other hand, the non-professional character of so much of the Colonial and American services relieves them from a large share of the disadvantages attaching to the bureaucratic as distinct from the self-governing system.

In passing from the general consideration of administrative government to its special relation to labour questions, it is possible to form a rough classification of the countries under review. The Colonies and America fall naturally into a group apart as illustrating the most complete development out of England of the self-governing principle. Amongst European nations the Teutonic countries stand first, and may perhaps be subdivided according to their degree of industrial development and their position in the labour movement. Though the smaller countries, Switzerland, Holland, and the Scandinavian group, have advanced furthest in the direction of decentralisation and emancipation from bureaucratic control, the prominent position occupied by Germany and Austria and their industrial importance place their efforts in the direction even of modified self-government in the front rank of European attempts to solve the labour question. Belgium affords a transition to the more purely Latin countries, which are as yet apparently but little capable of lasting association, and are, consequently, more fruitful in revolutionary propaganda than in any organised attempt to deal with labour difficulties. In close connection with the Latin group must be placed the Slavonic peoples of Eastern Europe, far more backward in civilisation, but characterised by the same revolutionary tendencies, and equally incapable at present of patient organisation. Such a classification will necessarily require modification in detail, but with this mental reservation it affords a sufficiently accurate guide to the general aspect of the labour question.

It must be clearly understood that in drawing a distinction between the self-governing communities and the communities governed by bureaucracy it is not intended to suggest that the intervention of the State in labour matters is any the less noticeable in the one than in the other. The amount of so-called labour legislation is of infinitely less importance than the spirit in which that legislation is conceived. Australasia, with its strong representation of labour in Parliament and its labour peers, and the United States with its eight hours' Act, its department of labour, and its elaborate system of State bureaux are in no way behind the paternal Governments of Germany and Austria. The Bills introduced into Australian parliaments contain provisions which rival the most advanced legislation of France. But in the countries of Anglo-Saxon nationality, and especially in Australasia, labour legislation has followed, not preceded, the formation of a compact labour party. There may be those who think that the development of the Australian labour programme has been rapid, and that the demands of the new unionism would have gone far in the direction of socialism,

* Goodnow, "Comparative Administrative Law," vol. ii. p. 272.

had not the Unions suffered a severe check in the great strikes of 1890 and 1891. It must, however, be clearly recognised that in spite of the growing inclination to invoke the aid of the State, Australian trade unionists have served a sufficiently long apprenticeship in the art of government to preserve both their economic and their political independence. In the United States the intermixture of race and the tendency on the part of organisations to rapid rise and fall, make self-government more difficult; but here again there is a strong leaven of conservative trade unionism, which the recent policy of the Federation of Labour tends to foster, and a public opinion in favour of individual liberty. In spite of the socialistic tone of the publications of a motley association such as the Knights of Labour, the principle of self-help has always received wide recognition, and though the demand for legislation is loud and frequent, the absence of any penal sanction often renders this legislation more a record of public opinion than a means of coercing either of the two industrial parties. Further, the state of the law with regard to combination in both Australia and America, the unrestricted right of meeting, the complete liberty of speech, and the entire absence of any censorship of the Press, all alike encourage the formation of labour associations, and the free ventilation of grievances as well as of their possible alleviation. It must also be remembered that a suffrage which is practically universal, and in New Zealand, indeed, extends to women, places both the colonists and the Americans in a position to give direct expression to their wishes in the matter of legislation. It must be the work of the future to show how far a self-governing people will elect to fetter their own individual liberty by act of the Legislature and whether such Acts will or will not result in another form of class legislation.

Turning to Europe, it is at once apparent that there has been no such training in self-government as is afforded by the experience of colonial or American trade unions. Even here, however, it is not difficult to trace the influence of English methods upon the labour movement in the Teutonic countries. The degree of freedom enjoyed by Switzerland and Scandinavia would afford the closest parallel, but both countries, owing to peculiar conditions, have not, as yet, been brought face to face with the same difficulties in an acute phase. Sparseness of population, and backward industrial development have retarded the progress of Socialistic agitation in Norway, Sweden, and Denmark, though within recent years there has been a very considerable advance. The absence of great capitalists, and the relative equality between the two industrial parties has, as yet, failed to call out the strongest qualities in the elaborate organisations of Switzerland. Holland moves but slowly, owing to the leisurely habits and comparative content of her thrifty people, and it is to Germany and Austria that we must turn for the greatest advance upon English lines. Even here the self-governing principle has made but little way. The organisation of a conservative labour party is rather a hope than an achievement. Up to 1890, revolutionary socialism in Germany required to be held back by the strong hand of a Bismarck, even though freedom of combination and universal suffrage were educating the German people in habits of self-government. The comparative failure of the attempt to imitate English organisations directly by the formation of trade unions (*Gewerkvereine*) both in Germany and Denmark proved, perhaps, the necessity of previous training. At the same time, the efforts of the German Government to promote the interests of the working classes, and to anticipate their demands by compulsory insurance laws and factory legislation, were received with grudging recognition by the classes which such measures were intended to benefit. State Socialism, or the beneficent Government — the ideal of the academic socialists and the younger and more enlightened German bureaucracy—has not of itself provided an adequate solution for the labour problem. The severer training of repressive legislation, with the consequent necessity for perfecting methods and consolidating organisation, appears to have done more to teach Social Democracy the art of self-government. Whether or not the German workman is as yet sufficiently far advanced in that art to wait patiently for his opportunity, and to modify the Government's protective legislation "in Parliamentary fashion" is again a question for the future. Amongst the races in which the Latin element predominates, Belgium and France have been especially prominent, both in the demand for legislation and in the revolutionary spirit displayed by their political agitators. Widespread strikes for political ends, and terrorism exercised by the labour party, have gone far towards gaining universal suffrage for Belgium; and if Belgian labour legislation is as yet somewhat

backward, the attitude of the Belgian Government seems to promise large concessions. Spain and Portugal exhibit a supine indifference on the subject, possibly owing to the small development of labour organisations. Both here and in Italy the labour movement, even in its early stage, bids fair to assume a revolutionary character, and if there has not as yet been any loud demand for State interference, this is due rather to the incapacity of the people to formulate their wishes than to any preference for the method of self-help. The Italian co-operative movement may possibly become the nucleus of a conservative labour party, but it is as yet too little developed to exercise any appreciable political influence. The solution of the labour question, as far as the Italian Government is concerned, has not as yet made any great progress, and the economic misery of a large portion of Italy affords abundant scope for its future activity. At the same time the legislation already introduced is an earnest of a serious intention on the part of Italian statesmen to deal with the question, whilst in Spain an almost total failure to convert any proposal into law seems to throw a doubt upon the possibility of any political solution. France, however, more than any other country, exhibits the incapacity of the Latin races for patient self-government. Here the acquisition of power by the labour party has been extraordinarily rapid, and at the same time the political privileges possessed by the working classes are exceptionally numerous. The disproportion between the number of associations and the tale of their members illustrates the tendency to form revolutionary centres rather than self-governing bodies, and affords a striking counterpart to the centralised system of administration. The concentration of the labour party in the capital, the system of labour exchanges, the influence of revolutionary socialism in the Chamber of Deputies, the power of that Chamber over the administration, and the menacing attitude which the labour party, both within and without the Chamber, adopt towards the Government are grave features in the French labour question. At the same time, the encouragement given by French law to co-operation and profit-sharing, the provision for the peaceable adjustment of minor disputes, and similar measures of a moderate character, should exercise a steadying effect upon the movement, whilst the attitude of comparative determination recently adopted by the French Government when face to face with Anarchism, seems to promise that a limit will be set to official compliance with agitation. The same revolutionary tendencies which characterise the Latin races reappear amongst the Slavs, but here the attitude of the governments is one of stern repression. Little is done to alleviate labour troubles by legislation in the interests of the working classes, and such legislation as exists proceeds entirely from above. It does not appear as yet to have come within measurable distance of the real sources of the revolutionary movement.

The influence which Roman law has exercised upon the Continental labour question has in more recent times been succeeded by that of the Catholic Church; itself, according to the fine saying of Hobbes, "nothing else than the ghost of the Roman empire sitting crowned upon the grave thereof." Nor is this succession to be regarded as a mere flight of the historic imagination. Mr. Hall, in his "International Law," has pointed out that hierarchical ideas and a theory of "law imposed by a superior" were the natural characteristics of a religious epoch, and that in the hands of the Spanish jurists of the 16th century they have left an indelible impression upon Continental legal theories. Though in Protestant hands, the idea of "natural right" superseded that of a Divine law enshrined in the ordinances of the Church, and finding expression through the Holy See, the result of both theories was deductive uniformity rather than the gradual development of rules as demanded by actual experience. It is not, therefore, difficult to understand why, even apart from its more recent social activity, the Catholic Church should have exercised so strong a determining influence upon labour questions. Endowed as it was with the prestige of the Roman empire, inheriting both the hierarchical and the imperial tradition, with a long historic past and, at the same time, with a pressing need to vindicate its claims over nations menaced by advancing Protestantism, the Church of Rome was imperatively driven to espouse the cause of the working classes. If in earlier times the higher clergy were content to leave the poor to the ministration of the friars, the 19th century has seen Rome awake to a new sense of its opportunity as the champion of labour against capital.

The wisdom with which the Roman Church has made a virtue of necessity, and the in-

sight which it has displayed in seizing upon the most effective means, not only of maintaining but of advancing its position, can be illustrated by a comparison of the different degrees of activity which characterise it in different countries. In the most Catholic countries Catholic Socialism may be almost said to be conspicuous by its absence. In Italy, where, as a Catholic writer like Professor Francesco Nitti has stated, "the Catholic clergy are not called upon to do battle for their faith in the face of an active Protestantism, and the struggle between the spiritual and temporal powers debars them from taking an interest in secular politics," the clergy are for the most part content to attend to purely ecclesiastical matters. Obliged by the direct influence of the Vatican to hold aloof from the State, they are unable to further the protective labour legislation, which in other countries forms part of the Catholic social programme. In Spain again, the home of rigid Catholicism, there appears to be little of the modern tendency to form an alliance with the labour party. The political situation has exercised the same demoralising effect as in Italy, and the Catholic clergy prefer to mix in Carlist and Ultramontane intrigues, with a view to recovering their hold upon the temporal power, to exerting the influence which they might exert upon the labour movement. Since the publication by Leo XIII. of the "Encyclical on Labour," in 1890, some steps have, however, been taken by the Spanish clergy, and especially by the Jesuits, towards the formation of Catholic workmen's associations.

These associations have assumed far greater importance in the Teutonic countries, where Rome finds herself under the daily necessity of justifying her existence in the face of a growing tendency on the part of the Protestant Churches to take their share in sympathising with the labour movement. If at the outset the Catholic Socialist movement in Germany was due to the distaste felt by prominent Catholics for the independent and materialist teaching of the Liberal party and the Manchester School of Economists, it appears equally clear that the campaign undertaken by Prince Bismarck against the Catholic Church forced it into quickened social activity. Now that the struggle with the State has been relaxed, there remains the need for keeping pace with the newer Protestant Socialist movement, and the Catholic or Christian Socialists continue to organise associations of every kind, and to issue periodical programmes affirming the right to labour, and demanding "a remunerative, assured, and gradually rising scale of employment." But whilst calling attention to the political and ecclesiastical inducements to activity, it must not be forgotten that both in Germany and in lesser Teutonic countries, such as Switzerland and Holland, the Church of Rome has done golden service in awakening the employing classes to a sense of their responsibilities, and in supplying the working classes with an education in organisation. Although the Catholic tradition of dependence upon authority tends to leave out of sight the element of self-reliance which to an English mind constitutes the chief virtue in association, Catholic example has apparently been needed to point the way. Even in Germany the Protestant Church was years behind the Church of Rome in social matters; in Switzerland, Holland, and Denmark, Rome is already active, whilst Protestant interest in labour questions remains merely a possibility of the future.

The less admirable side of Catholic socialism assumes greater prominence in France and Belgium. Here, again, the Church of Rome reaps all the benefit which may and does result from a struggle for existence. At the same time it is subjected to the deteriorating influence of a conflict, in this case not with another and hostile Church, but with an anti-religious and revolutionary socialistic movement, which it is not strong enough to master, but with which it finds it necessary to compete. Once embarked upon the hopeless attempt to outbid a party prepared to go all lengths, it is not difficult to see the political and social shipwreck to which Catholic Socialism cannot but contribute, unless it takes refuge in a policy of reaction. Mr. Condie Stephen has sketched "the two extreme political parties in France.... who are straining every muscle to weld the wage earners into formidable battalions.... While one is endeavouring to convert by holding out prospects of an order that may never be realised, the other is seeking to enroll recruits by a system of patronage and privilege, of which the ordinary workman is quite prepared, occasionally, to avail himself, without necessarily being converted to the doctrines preached." But even if Catholic Socialism marks, as Mr. Stephen thinks, "a skilfully veiled reactionary tendency," based upon "hierarchical ideas and prejudices," as long as the veil consists in an attempt to anticipate the

proposals of revolutionary collectivism, there seems reason to fear that the programme of the party will become socialistic at the expense of its Catholicism. In such a case, it can but serve as one more weapon in the hands of persons hostile to any form of religious faith. The position of affairs brought about in Belgium by difference of race and religion, combined with Catholic recklessness of the political consequences of their propaganda and Catholic determination to oppose every sort of liberal compromise, has been sketched by a recent writer, whose strong Liberal convictions have led him, perhaps, somewhat to over-state his case:—"The Flemish population is essentially agricultural, Catholic, and reactionary, and in politics it is entirely in the hands of the Ultramontanes and their bishops. The Walloon and French section is just as essentially industrial, socialistic, and free-thinking, and in politics it is too often in the hands of agitators. . . . In 1878, the intolerance of the bishops led to a disastrous struggle. Liberal Catholics were excommunicated by battalions, and so severe was the crisis, that the administration of M. Frère-Orban was nearly compelled to break off all relations with the Vatican. Since that date, the religious difficulty has blocked all reform, and has paralysed all the efforts of the Liberal party." The extension of the franchise granted by the Belgian Government in a panic during the violent strike of April, 1893, will, in the writer's opinion, lead to "a central Government, with a clerical and reactionary majority,* face to face with a Socialist local and municipal Government. On the one side, the 'International' of the priest with the black cowl; on the other, the 'International' of the socialist with the red cap of liberty. It is the picture of a pair of oxen of different breeds yoked together, and fighting without mercy and without quarter."

This picture is, perhaps, highly-coloured, but there is little doubt that the younger Catholic clergy are prepared to go much further on the road to Socialism than the Papal Encyclical warrants. Whilst the older clergy devote themselves to the formation of joint associations, the younger clergy confine their attention to the organisation of labour. The one interpret the Encyclical as a condemnation of certain evils within the existing social order, the others declare that it demands an entire reconstitution of society. From this point of view they claim that it is to be regarded as infallible, a proposition which the elder men are disposed to deny. Thus Belgium has not only a Catholic party face-to-face with Socialism; it has a Conservative Catholic party face-to-face with a body of Catholic Radicals, recruited mainly from the ranks of the secular clergy, who have little to lose and everything to gain in a struggle with the Socialists for popularity. But recent events have given ground for belief that the Roman Catholics who were triumphant at the polls in 1894 will use this power with moderation.

The liberty of action, and the consequent participation in political and social questions, which, according to Professor Nitti, decreases in direct proportion to the vicinity of the Vatican, finds naturally its fullest development in Canada and the United States. Over and above the strong Catholic element introduced by an immigration drawn largely from Ireland, Italy, and Austria, the splendid tradition of Rome, its hierarchy, and the magnificence of its ritual find a sympathetic response among a people as susceptible as the Americans to even the semblance of aristocracy. Moreover, Rome has known how to use her opportunity. In spite of the opposition which she encountered in the middle of the century, "she has emerged victorious from the competition with the multifarious Protestant bodies," and has "gained both in power and in numbers, whilst they have been disputing amongst themselves." Under the able leadership of Cardinal Gibbons, she has taken a prominent part in the labour movement; her influence predominates in the great Order of the Knights of Labour, and, indeed, so close was the sympathy felt by her bishops for the aims of that Order, that they brought strong pressure to bear upon the Pope himself, to induce him to rescind his ill-advised excommunication of its members. This is only one of many signs that the Catholic Church in America is characterised by an enlightened independence, which compares favourably with its policy in Europe, and affords a strong contrast to the Conservative attitude of the late Cardinal Taschereau in Canada. It omits no opportunity of displaying its zeal for the interests of labour, whilst, as Archbishop Ireland has recently stated, it holds aloof from all revolutionary tendencies. It is aided in this by the political conditions of the country, and by the peaceable character of the industrial struggle —as compared with its aspect in France

* N.B.—It has already done so. *See* article in "Fortnightly Review" for February.

and Belgium. At the same time there is a tendency, even here, to go beyond the position adopted in the Papal Encyclical, the authorised guide for all Catholic action in labour matters. Though Leo XIII. has, apparently, advanced since the Encyclical against Socialism of 1878, both in the Encyclical of 1890, and in that of 1893, he still expressly repudiates "Anarchy and Socialism," as inconsistent with the teachings of religion, and affirms "the sacredness and inviolability of private property." In spite of this, the American bishops have thrown in their lot with an association which aims at the subversion of the capitalist and the destruction of the wage system. In short, though the assertion of the "natural right to live and work" is the most extreme utterance, even of the Encyclical of 1893, it can hardly be said to be the most advanced proposal of Catholic socialism as interpreted by the clergy, whether of Europe or America. Nor does it appear probable that the social remedies which they advocate will begin and end with the Papal recommendation to form workmen's associations upon a religious basis.

The indifferent attitude towards the labour movement adopted by the Church, which is known under the various titles of Orthodox, Eastern, and Greek, is in striking contrast to the social activity displayed almost everywhere by the Church of Rome. This contrast is, however, intimately connected with the essential difference between the two Churches. Whilst the Church of Rome recognises progressive development in the interpretation of doctrine, the Orthodox Church admits of no deviation from the body of primitive dogmas and ceremonies. Again, the infallible head, who is for Rome the ever present guide in determining the course of development, has no place in the Orthodox Church. Thus, whilst "the Western Church is governed by an attractive force which draws all towards a common centre and gradually obliterates local and national peculiarities, in the East a centrifugal force multiplies centres of energy and gives every people an independent Church." The immobility, therefore, of the Eastern Church as a whole, and its tendency to division upon national lines, must be taken as the two distinctive marks which characterise its attitude towards the labour movement. It has, in the words of M. Leroy-Beaulieu, been "stagnant for almost a thousand years and, so to speak, petrified in its traditions, whilst Catholics and Protestants were each developing the root idea of their faith, one advancing towards authority and centralisation, the other towards individualism and liberty of judgment." Though occupying this intermediate position, the Orthodox Church cannot be regarded as in any sense colourless, or as offering a solution of religious difficulties which partakes of the nature of a compromise. On the contrary, its rigid discipline, its gorgeous ritual, its manifold ceremonies, and its insistence upon unqualified submission to authority in respect to the body of doctrine determined by the Councils of the Church, raise it far above any suspicion of indecision or weakness. Its immobility must, according to M. Leroy-Beaulieu, be attributed largely to its geographical position, just as its national character is the fruit of its historic development. If, as M. Leroy-Beaulieu has said, "the faithful members of this great Church cannot deny that its place in the history of civilisation is not to be compared with that of Latin Catholicism," it must not be forgotten "that a religion is often what it is made by its professors . . . . External influences, independent both of race and religion, have arrested or retarded the civilisation of the Orthodox peoples. The long sterility of the Church has its source in the peoples, and both alike spring from the defects in their secular education . . . . History may in its turn ascribe the fault to geography, to the position, namely, of all these orthodox nations on the frontiers of Christendom in the least European of all European countries, and the most exposed to incursions from Asia." Engaged in a constant struggle against the barbarian and the Mussulman, it is not surprising that the Eastern Church should have developed such a strong sense of nationality. From the point of view of progress, it is unfortunate that that nationality should be so predominantly Russian, and that the triple device of the Emperor Nicolas, as of his grandson and successor, "Autocracy, orthodoxy, nationality," should emphasise at once the strength and the weakness of the national principle. Out of a membership of a hundred millions, eighty millions are Russian subjects, and for four-fifths, therefore, of the Orthodox Church orthodoxy implies unquestioning submission to the autocratic rule of the Czar. Though recognising no earthly head, the stress laid by the Russian Church upon the sacred character of a divinely appointed and consecrated monarch has, in effect, converted autocracy "into a patriarchal theocracy, merely

disguised because of the requirements of the times and the neighbourhood of a bureaucratic and military monarchy." Nor is the influence of the Czar, as ruler by Divine right, confined even to his eighty million subjects. The tendency on the part of the Russian peasant to connect community of religion with nationality leads him to respond readily to any demand on behalf of his orthodox brethren in Austria and in the Balkan provinces, and the religious fervour which possesses him might, as M. Leroy-Beaulieu has suggested, at any time convert his gradual advance over the Caucasian frontier into a crusade which should sweep downwards with the hosts of pilgrims to the Holy Sepulchre.

But in this intimate connection between Church and State, it is the State which reaps the largest share of advantage. The Government of the Czar gains the added strength of strong religious sanction, but the Church becomes infected by the stereotyping influence of autocratic suppression of liberty. It suffers, indeed, from a double dependence. "There can be no freedom in a State in which nothing is free . . . . no rights under a rule which reserves everything for Cæsar." At the same time, the dependence of the Church as a whole upon the Czar has its counterpart in the dependence of the individual clergy upon his subjects. Even if the higher clergy could become sufficiently emancipated to exercise any independent influence upon the labour movement, that influence would be largely discounted by the ignorance and rapacity to which poverty has reduced the lower clergy. To the peasant, a church "in which everything must be paid for whilst there are no fixed charges," could scarcely appear anything but an instrument of oppression, were he ever to awake from his present attitude of lethargic superstition and to take an intelligent interest in labour questions. The enlightenment, which would be the first fruit of his awakening, would only serve to show the Church as an obstacle to progress, not in any sense as a guide and director of the labour movement.

It is difficult, therefore, to ascribe to the Orthodox Church any influence upon the political and industrial development of the working classes other than a retrograde influence. Nothing can be clearer than that the leaders of the revolutionary party, which constitutes the only attempt as yet in Russia to touch the labour question, have detached themselves entirely from any ecclesiastical influence. The strong religious instinct of the Russian has in their case found satisfaction in a devotion to the cause of revolution. The Nihilists have merely changed their religion, instead of abandoning it; and it is to religious exaltation that Nihilism owes its fervour and force. That moral strength has had to fall back upon the weapons common to all revolutionists only marks the degeneration which, of necessity, attends upon all violent and sudden upheavals of an oppressive existing order. Whilst Nihilist zeal, therefore, threatens both Church and State, the Church attempts to dispose of religious revolutionists and sectarians within her borders by planting them out in the outlying provinces. The concentration of missionary zeal upon the Asiatic frontiers, though likely, from the ecclesiastical point of view, to lead to the advance of Christendom, is not without its political dangers from the point of view of other European countries. A Russian advance into Asia, such as that pictured by M. Leroy-Beaulieu, is as little to be desired as the multiplication amongst Teutonic peoples of elements likely to further the spread of Orthodox and, consequently, Pan-Slavist Christianity. Austria already includes some two or three millions of Greek Catholics, Schismatic and non-Schismatic, and Hungary, between three and four millions; whilst the Balkan provinces are almost exclusively Orthodox. At present, Hungarian Protestantism and Polish Roman Catholicism constitute a barrier against further extensions, but any failure on their part to preserve their frontier, and to keep up their race traditions, would open the way to the advance of the Slavs, already strongly concentrated upon the Russian frontier.

If the more admirable side of Catholic social activity is displayed where Catholicism comes into closest contact with Protestantism, it may be said conversely that in Europe, at any rate, no great sympathy has been shown for the labour movement by the Protestant churches, except in the two countries, Germany and Hungary, where Protestantism is continually on the defence against Roman Catholic advance. Although the Anglican Church took an active share in attempts to improve the condition of the working-classes at an early period, other Protestant Churches seem to have required the stimulus of Catholic example. In Norway, Sweden, and Denmark, as well as in Holland and Switzerland, the Protestant clergy have long shown an indifference to the labour movement; but the recent

rapid advance of Socialism in Denmark appears to have roused the Church to a sense of its danger. A great increase of charitable activity has been the result of a letter, issued in 1888, by the Danish bishops; but here the work of the Church has stopped, and it has not sought to take any more direct share in the organisation or direction of labour. A narrow and intolerant orthodoxy has estranged the Dutch clergy from the leaders of any movement, which they can stigmatise as "free-thinking." The Swiss Protestants have, up to the present time, been regarded by the Liberal party as the great enemies of progress: but the tendency to emulate Germany's method of dealing with the unemployed, and perhaps a greater attention to economic questions on the part of Protestants, seem likely to modify the indifferent attitude of the Protestant Churches. The very recent nature of all these indications of a wider social sympathy in the smaller Protestant countries points, however, to the conclusion that German influence has been at work. Though the Protestant Socialist movement in Prussia is comparatively young, it is older by 20 years than any similar efforts in other European countries. It is itself the tardy fruit of the revolutionary crises of 1848, and of the "Memorial to the German nation" issued by Pastor Wichern, the father of the "Inner Mission."* Thirty years later a Protestant Socialist movement was inaugurated, but through the indiscretion of some of its leaders, and possibly through the hampering effect of State control, its result was meagre and unsatisfactory. Within the last few years Protestant Socialism has gained fresh vigour. The younger clergy have realised vividly that the spread of social democracy constitutes an increasing menace to the very existence of the Church. Both the trained "brothers" and "sisters" of the Inner Mission and a large number of voluntary assistants are organising schools, homes, kindergartens, *crèches*, and other institutions for the benefit of the working-classes. Special attention is being paid to the formation of boys' clubs and clubs for working men, and a strenuous effort is being made to develop these clubs into self-governing associations on friendly society and trade union lines. The whole system of care for the unemployed is largely worked by the Protestant agencies, and the labour colonies are often directed by brothers of the Inner Mission. In Hungary the Protestant Church is specially active in the cause of education, and the excellence of the Protestant schools has called forth tributes of admiration from Catholics themselves. Both countries have still great difficulties to surmount. In Germany, social democracy has obtained such a hold over the working-classes as to make them insensible to the need of any ideal other than that of the Socialist State. Though Hungarian socialism has made less progress it is still strong in the large towns, and no Church has done much to secure the affection of the working-classes. The German Church again is hampered by State control. The Protestant clergy, who would be ready to move with the times, "are well-nigh helpless under the iron hand of the Government acting through a State Church." Freedom of thought and of discussion, though the logical consequences of the root idea of Protestantism, are difficult to realise, and the clergy are consequently at a disadvantage when attempting to meet the Socialists upon their own ground. America and the Colonies afford an example of the opposite extreme, entire separation between Church and State, and the recognition of all denominations as upon an equal footing. It scarcely, however, needs English experience to prove that freedom of speech upon labour questions can be enjoyed by the ministers of an established Church, and that the independence afforded by endowments is a stronger guarantee of impartiality than such a position of financial dependence upon their congregations as is often the lot of American clergy. The activity of many associations of a religious character, such as the Young Men's Christian Association, is a marked feature of American and Colonial society, and Christian Socialism has recently made considerable progress amongst the American clergy. In Melbourne the Salvation Army took the initiative in the movement towards establishing free registry offices for the unemployed, but the religious character of the institution appears to have qualified the favour with which it was viewed by the classes whom it was intended to benefit.

The geographical distribution of Protestantism calls attention to the fundamental principle which is at once its strength and its weakness as a social factor. To a large extent it coincides with the degree of self-government attained by a people. Strongest

* The "Inner Mission," was the outcome of a revival movement in the Lutheran Church in 1848, inaugurated by Pastor Wichern, with the object of "quickening the social activity of German Christians through the power of Christian love and its zeal for the common good."

in countries of Anglo-Saxon descent, it finds its largest number of European adherents in the Teutonic countries which have already been described as offering the closest parallel to Anglo-Saxon political traditions. It has been often reproached for the strength of its individualism, and its comparative indifference to the labour movement in Europe has given colour to the charge. But if the Church, which, with Luther, bids the labourer be careless of temporal alleviation and submissive to his masters, may at times incur the reproach of insensibility to social injustice, it must also be admitted that its very individualism proves its safeguard when social activity becomes inevitable. The tendency noticeable in Germany to form independent self-governing groups, the Hungarian sense of the paramount value of education, the American encouragement of mutual improvement and provident societies, are all efforts on the side of self-help, which cannot but contrast favourably with the Catholic ideal of dependence upon authority. The sterner discipline may result in a slower progress; at the same time, it can scarcely be doubted that the progress will be in the direction of self-government. Modern Socialism, indeed, professes to offer a substitute for religious activity, but the probable result of its gospel, and the inefficacy of its sanctions, need perhaps only to be realised to ensure its repudiation.

Beside the direct attempts of Governments to find a solution of the labour question in legislation, and the claims of the churches to offer an answer to the prevailing difficulties, there remain the efforts made by society to bridge over the gulf between employers and employed. Omitting, for the reasons already stated, the struggle of the employed to find their own solution by organising themselves into a body sufficiently strong to make their wishes felt, the action of employers and of other social classes may be broadly distinguished as either philanthropic or educational. The intimate connection of both these forms of activity with politics and religion makes it impossible to keep the social solution of the labour question entirely apart from its political and religious aspects. At the same time, so many philanthropic and educational movements are largely voluntary or secular, that they cannot be rightly confounded with the action of either governments or churches. The relief of the poor and the provision of work for the unemployed are the two chief spheres of philanthropic activity. In most European countries poor relief is far more a matter for voluntary effort than in England and in countries like the United States, whose Poor-law is framed upon the English model. Even in countries with a regular and elaborate system of Poor-law administration, such as exists in Germany, the discretion allowed to the individual visitors in determining the nature of the relief afforded, and the large number of unprofessional and unpaid assistants pressed into the service of the Poor-law administration, are more suggestive of the methods of a charitable society than of an administrative department. If even the Teutonic countries, with their organised systems of relief, allow large scope to the voluntary principle, the Latin countries have restricted the domain of public administration even more narrowly. France, Italy, and Belgium recognise no obligation on the part of the State to extend its aid to any but lunatics and deserted children; all other persons in need of assistance are relegated to the care of individuals or of the various charitable societies over whom the State exercises a more or less close control. In Russia no direct aid is afforded by the State, and the philanthropic societies attempt in vain to cope with the vast mass of pauperism and mendicity. Without going at length into the comparative results of departmental and voluntary poor relief, it will suffice to point out that, if the tardy action of the State is the opportunity of the charitable, it is by no means certain that in this department of social activity the sterner and more repressive attitude of the Poor-law administrator can be adequately replaced by the officials of voluntary societies. These societies can, however, do much to supplement the working of the Poor-law. The American Associated Charities and the German Women's Unions both afford examples of the beneficial effects of such private action. Though this American counterpart of the English Charity Organisation Society suffers from a disproportion between work and workers, and occasionally sighs after the German ideal of compulsory service, it has, nevertheless, done good work in the great cities of the Eastern States. It is said "to be enlarging its field of usefulness year by year," and to be doing away with the indiscriminate bestowal of charitable bequests and donations which, to take only one out of many instances, had succeeded in more than doubling the blind beggars of New York. It is worth noting that the Associated Charities

avail themselves largely of the service of women, whose special qualification for many branches of philanthropic activity has led them in Germany to compensate themselves for their exclusion from Poor-law administration by undertaking a large amount of voluntary work. The care of the sick, the education of orphan children, and the management of many institutions for the benefit of their own sex, have been the special province of the *Frauenvereine.*

Provision for the unemployed aims, perhaps, at a more direct solution of the labour question than any system of poor relief. If the one attempts to alleviate the poverty resulting in part from a disproportion between supply and demand in the labour market, the other endeavours to prevent that disproportion from coming into being. It cannot, however, be said that this endeavour has been crowned with any great degree of success. It has taken the threefold form of establishing agencies to bring employer and employed into direct connection, providing shelters for workmen travelling in search of work, and, in the last resort, giving them work in a labour colony or settlement. Labour registries fall, in many cases, under the head of political rather than social activity in the labour movement, owing to the fact that they are so often under State or municipal control. In France, where they have had the widest and, at the same time, most revolutionary development, they are hardly, if ever, the result of private desire to benefit the working classes. Australia has more Governmental than private registries, but in Germany and Switzerland there are several instances of voluntary initiative. Shelters for travelling workmen and labour colonies are especially remarkable in Germany, and are the outcome of a movement partly religious and partly independent. The Protestant clergy have interested themselves especially in the colonies, and both Catholics and Protestants attempt to gain an influence over the migratory population of the shelters. It can hardly be said that the German colonies or the less numerous institutions of Holland, Belgium, Switzerland, and France have effected more than a temporary absorption of a relatively small amount of casual and inferior labour, nor does there appear any reason to believe that even the obligation to proceed only upon particular routes has any special terrors for the German vagrant.

The direct interest shown by employers in promoting the welfare of their workmen by providing them with libraries, reading-rooms, baths, *crèches*, and other institutions might be expected to do more to create a good feeling between the two classes than the action of outside persons. At the same time it must be admitted that where the employers have shown themselves specially active, they have too often partly justified the suspicion that they were prompted more by a dislike to the workmen's own efforts in the direction of organisation than by a disinterested desire for their welfare. It is certain that in the Colonies and America, where organisation is strongest and most self-governing, there has been the less need for the aid of employers, and that in France where *œuvres patronales* have been established most widely, they appear to have militated against the growth of stable associations amongst the workmen. In Holland again, with its weak organisation of labour, employers have been specially active, and though it is not intended to suggest that there is any essential necessity in this conjunction, it is perhaps characteristic of the present phase of the labour question. The same result appears in the movements which are predominantly educational. General and technical education, the improvement of workmen's dwellings, and efforts to promote temperance, such as the Gothenburg system, or the Swiss alcohol monopoly, would all probably meet with a greater degree of success were they the result of a struggle for self-education, instead of so largely an attempt on the part of the State or of society to impart to others what the others are scarcely ready to receive. Hence the decrease in the consumption of brandy is in Sweden counterbalanced by an increased consumption of beer, and the blocks of workmen's dwellings in Germany are said to lead to promiscuous mingling of persons of all ages and sexes. It has, indeed, been claimed for this system by the Social Democrats that it is a step towards the destruction of the present "unitary" form of the family. Though, perhaps, these facts may not amount to more than the degree of abuse attendant upon the earlier stages of any movement towards social reform, they at least deserve attention in so far as they mark the very early stage which is all that has been as yet attained.

In education proper the effects of rapid advance have been of a different character. Technical education, even where it is most highly developed, as in France, is still so much in its infancy that it can hardly be said to exercise an appreciable effect upon the

labour movement. It is valuable chiefly as indicating an attempt to prevent that conversion of the artisan into a machine, and his consequent divorce from his tools, which constitutes one of the most frequent reproaches brought by the Socialists against capitalist production. In general education, however, the advance has been rapid—possibly, in a sense, too rapid. The multiplication of secondary schools and the widening of universities has, both in the Old World and in the New, brought into existence a large class of persons whose training has rendered manual labour distasteful to them, and who, at the same time, are often at a loss to find a market for their brain-power. It is from this "intellectual proletariat," as they have been named in Germany, that the ranks of Socialist agitators are largely recruited. The vague unrest which culture, rapidly acquired and without any corresponding make-weight of inherited tradition, industrial responsibility or training in the school of self-government, scarcely ever fails to produce, constitutes one of the gravest features of the present social movement. To convert this revolutionary force into a body of useful citizens requires one of three things, or, perhaps, a combination of all. It requires, in the first place, political freedom, acquired after a slow progress upwards, which is in itself an education; it requires, further, a common ideal which will satisfy both the intellectual aspirations and the religious instinct; and it requires, finally, the habit of association for common ends afforded by co-operative and labour associations. In all these three elements the Continental countries of Europe have been shown to be weak. Political freedom has either advanced so little, or been seized so suddenly, that it has not yet been able to cope with the movement. The solution offered by the Churches has either failed, as in the case of Rome, to allow adequate liberty to the individual, or, as in the case of the Protestant Churches, to show sufficient sympathy for the needs of the times. The organisation of labour upon a sober and self-governing basis is still far to seek. Apart from some of the more recent tendencies of the Teutonic organisations and the nascent co-operative societies of Italy and France, there is little sign as yet of the formation of anything more than a nucleus of independent and non-socialist association amongst the working classes. It is, therefore, not strange that when Socialism comes forward with a theory of the reconstruction of society upon lines which will blot out all existing evils, and with an appeal to the self-devoted and even religious instincts of humanity, it meets as it does with so immediate and widespread a response. Even in America, where organisation and self-government have effected much, there is still the intellectual proletariate, with its "aversion to manual labour," and its restless craving for a new social theory. In the colonies there is the great army of the unsuccessful swelling the ranks of the unemployed, and all alike claiming from the State the realisation of the Socialist theories. The colonies, the United States, and the older countries, each in their several degree find themselves face to face with the same problem—widespread acceptance of Socialist doctrine, and the difficulty of strengthening the opposite elements in society to a corresponding degree. The action of governments and of churches seems at times to countenance the prevailing theory, whilst the sounder elements amongst the working classes are scarcely able to hold out against a tide which threatens to sweep them into its vortex before they have had time to perfect their organisation, and establish their right to independence by the success of their struggle. In view, therefore, of this preponderance of the Socialist elements in the general labour movement, it remains to consider the past and present of foreign Socialism, and the nature of the solution which it offers to the labour question.

From the point of view of the present labour movement, Socialism in Europe may be said to date from the efforts of the Communist League, which originated in France, but in which Karl Marx and Friedrich Engels soon became the leading spirits. With the reception of Marx into the league in 1847 began that long ascendancy of German Socialism and of the particular phase of it still known by the name of Marx, which triumphantly asserted its title to predominance in the Socialist Congress at Zürich, of 1893. Whether or not Marx is to be considered an original thinker, it is certain that the economic doctrines of "Das Kapital" have abundantly proved their right to be regarded as the gospel of Socialism. Socialism, since 1848, has passed through three phases, the first revolutionary and tentative, the second marked by rapidly increasing organisation, and by outbreaks of violence which provoked reprisals on the part of the various Governments, and the third a period beginning with Governmental repression, but ending in greatly increased liberty of action, and marked throughout by growing consolidation. Broadly speak-

ing, these three periods may be fixed as from 1848 to 1864, the year of the formation of the International, from 1864 to 1878, the year of the German law "against the generally dangerous efforts of Social Democracy," and from 1878 down to the present time. Of the first of these periods there is little to be said. The failure of the hopes which had been based by Karl Marx and his friends upon the French Revolution of 1848 forced them to retire for a time into obscurity, and in 1852 Socialism was by many people thought to be dead. But the revolutionary wave which—as at an earlier period—had swept from France over Europe, had left its mark upon the working classes, and had aroused a general feeling of discontent, easily quickened by any recrudescence of Socialist agitation. Socialism made its next appearance as a German movement on German soil. The advent of Lassalle, as a social reformer, early in the sixties, his declaration of the inherent right of the working classes to sovereign power, and his demonstration of the crushing effect of the "iron law of wages," combined with the efforts of Marx to give the impetus needed to bring about the second period, the period of organisation.

In 1864, the year of Lassalle's death, an association on the widest principles was inaugurated in London. The International Association of Working Men included at the outset some fifty representatives of England, France, Italy, Poland, and Switzerland; but its available funds scarcely exceeded £3. Its object was the affiliation of all workmen's societies throughout the world, with a view to common action upon labour questions. Nothing was required of members but adherence to the principles of the association and the payment of a small subscription, which the International too often found itself unable to enforce. This was not the only difficulty which beset the association. From the first, widely different conceptions of its nature and objects were cherished by different sections. To the English members it appeared in the character of a magnified trade union; but many of the Continental members regarded it as a means of bringing about the social conflagration which was to inaugurate the new era. Whilst one party was looking to it to aid them in maintaining the rate of wages, the other party expected it to abolish the wages system altogether. At the very outset, therefore, the essential divergence between the aims of a working-class movement adopting a Socialist aspect and the aims of revolutionary Socialism began to make itself felt. The difficulty, which has since recurred towards the close of each period, of keeping the extremer tendencies in check, was met at first by the moderating influence of Marx. Anarchist principles were kept in the background and the formation of workmen's associations grew apace. Almost every country in Europe was affected by the movement. It does not indeed appear to have penetrated further north than Denmark, and in Russia only one branch is recorded, but Central Europe, Italy, and the Spanish peninsula counted their branches by thousands. The branches were, however, more numerous than powerful, and the general tendency was rather towards undue exaggeration of the power of the association. Nevertheless, when it is considered in connection with the concurrent growth of organisation amongst the German and Austrian Socialists more especially, it cannot be denied that the International is a remarkable sign of the spirit of the Socialist movement in its second period. As the period advanced the strength of the dissentient revolutionists began to make itself felt. The excesses of the Paris Commune, of 1870, were the beginning of the end. Though these were not directly traceable to the International, many of the communists were members of the association, and a manifesto subsequently issued by Marx declared that the "martyrs" of the Commune "would be for ever enshrined in the great heart of the working classes." A great decrease ensued amongst the more moderate members of the association whilst internal troubles became more pressing.

In 1868 the Russian Bakounin, "the inspirer of all the revolutionary socialism in Europe since 1865," had organised the Alliance of the Jura, which at its own request was in 1869 affiliated to the International. "No centralisation, no State, not even a revolutionary dictatorship" constituted the political creed of the Alliance, and in accordance with its principles it proceeded to question the authority of Marx. At the Congress of the Hague in 1872 the leaders of the Alliance repudiated "a chief who constitutes himself a judge of heresies" and were in their turn expelled from the ranks of the International. The main body, however, only survived this exercise of authority one year, for the so-called International Association, founded by the followers of Bakounin, had

nothing international about it except its name, and would have been better described as an association of revolutionary anarchists, whose chief sphere of influence was Russia and Spain.

Meanwhile the organisation of social democracy had proceeded independently of the International in the principal European countries, though no country could show a development unchecked by internal dissensions. In Germany the followers of Lassalle and the followers of Marx proceeded to organise the German labourers upon slightly divergent lines up to 1875, when a compromise was effected and a joint programme issued by the Gotha Congress. The fierce denunciation which this concession called forth at the time from Marx himself only saw the light fifteen years later, so that the deep-rooted dissensions between the two parties were less apparent perhaps than real. Both agreed in discouraging Most and the anarchist section, and both suffered alike from the discredit which from 1872 onwards the violence of this small section brought upon social democracy in general. With the attempts upon the life of the Emperor and the consequent reaction of public feeling in favour of the adoption of a policy of repression, the second period of Socialism in Germany was brought to a close. The history of Austrian Socialism has proceeded upon very similar lines. It has been throughout strongly influenced by German example, and as early as 1869 accepted the Eisenach or Marxist programme. Up to 1871, it met with severe treatment at the hands of the Government, but as soon as it was granted a greater degree of freedom divisions began to appear within the party. The "Moderates" saw no hope of attaining their ends except by strengthening the hands of the Liberals, whilst the "Radical Labour Party," who sympathised with federalism and the national aspirations of the Czechs, developed distinctly revolutionary tendencies which were only kept in check by a temporary alliance with the "Moderates," concluded in 1875, the year of the German compromise. The "Moderate" party represents the German Social Democrats as led by Bebel and Liebknecht, the Radical party the subversive principles advocated by Most. In Russia, again, the latter half of the period, 1864 to 1878, was characterised by organisation amongst the Socialist or Nihilist party. The doctrines of Bakounin had gained wide acceptance amongst the educated classes, and an attempt was made to disseminate these views amongst the people by forming clubs for discussion, and by going in various disguises into the ranks of the peasantry. Repressive action on the part of the Government, and consequent recourse on the part of the Nihilists to "propaganda of deed" preceded by a few years the legislation which necessitated secret organisation in Germany. In 1874, wholesale prosecutions were instituted, and numbers of leading spirits banished to Siberia. A year later the Italian Government found it necessary to intervene for the purpose of checking the revolutionary agitation which was being conducted upon the principles learned from Bakounin amongst the Italian peasantry. About the same time the Socialist movement was declared illegal by the Spanish Government, so that throughout Europe the second period in the history of Socialism closed with repressive action on the part of the various Governments. France constitutes an exception. The severe measures necessitated by the Commune had somewhat anticipated the course of events elsewhere, and the revival of the party was similarly in advance of its revival in other countries. If, however, 1876 is substituted for 1878, and it is at the same time remembered that divergence of opinion within the party has in France been more characteristic of the third period than of the second, the development of French Socialism falls in with that of European Socialism generally.

Considerable difference of opinion exists as to the real influence exercised by repressive legislation upon the development of the Socialist movement, but there can be no question that its immediate effect upon the party organisation was little short of disastrous. The importance of German Social Democracy made the law prohibiting "societies which aim at the subversion of the existing political and social order by social democratic, socialist, or communist efforts" only so much the more far-reaching in its effects. Every form of open agitation was rendered impossible; organisations were dissolved, and very many of the prominent members of the party sought refuge abroad. In Austria, the law is said to have done almost more harm to the Socialist cause than in Germany, by inducing a feeling of faint-heartedness and despair among the more moderate members and encouraging the violent to insist upon the necessity for a social revolution. The great decrease in the number of German strikes during the next few years witnesses to the diminution of Socialist efforts; but after the first shock had passed, the party leaders turned their attention to fresh methods

of pushing their doctrines amongst the working classes. By means of secret committees, clubs nominally for mutual improvement and unconnected with politics, and the dissemination of Socialist literature, the interest of members was not only maintained but increased. If the last period in the Socialist movement began with depression, it ended with growing consolidation and more enlightened party tactics. Herr Bebel, the German Socialist leader, has himself borne the most eloquent testimony to the good effects of Prince Bismarck's policy by stating at the Zürich Congress that it had driven him and his friends to forsake revolutionary tactics for "their present policy of parliamentary action." This phrase, indeed, strikes the key-note of the last decade of Socialism. Germany has led the way, but Austria and the lesser Teutonic countries have followed closely in her footsteps, whilst even the more revolutionary Socialism of the Latin countries has adopted the same policy with a difference. Everywhere there has been an attempt to secure wider electoral freedom and to strengthen the party influence at the polls. Dreams of the Socialist State have been studiously subordinated by the wisest amongst the German leaders to present endeavour to secure the election of candidates to the Reichstag and the provincial diets, and though malcontents are not wanting to complain of the supineness of a party "which counts its progress by its successes at the elections," the majority of German Social Democrats point proudly to the quadrupling in sixteen years of their representation in the Reichstag, and to the increase of 172 per cent. in the Socialist vote of the large towns, and 803 per cent. in certain of the country districts.

If adversity has afforded the Social Democrats a lesson in the art of organisation and possibly, therefore, a training in self-government, the more favourable attitude now adopted towards the labour movement by the majority of European Governments has raised their hopes of acquiring political influence. The non-renewal of the Socialist Law in Germany, following as it did upon the series of laws for compulsory insurance, and coinciding with the Berlin Labour Conference and its promise of improved legislation for the protection of labour, gave a strong impetus to the Socialist movement. Similarly in Austria, where repressive measures had been taken six years later than in Germany, the Socialist party emerged from the "minor state of siege" and its accompaniments, "purged of its more revolutionary elements," and ready to reap its share of the advantages arising from increased freedom, and a general desire on the part of the Austrian Government to further the interests of the working classes. The first result of increased power and wider liberty was the convocation of congresses and the issue of party programmes. Internal divisions had been, for the most part, obliterated during the period of adversity, and the parties which met at Halle and Erfurt in Germany, and at Hainfeld in Austria, might claim, with reason, to represent almost the entire Socialist forces of those countries. Even before the final lapse of the German law in 1890, and of the Austrian law in 1889, their less stringent enforcement had rendered participation in international congresses possible, and to these meetings it is probable that much of the recent advance of Socialism amongst the lesser Teutonic and Latin countries may reasonably be assigned. The organisation of Social Democracy in Switzerland upon any permanent footing dates only from 1888, and up to 1892 the organisation was far from definite. The advance of the Socialist movement in Sweden has been as rapid as it is recent, whilst Holland, Denmark, and Norway have felt the effects of the new Socialist impulse.

The movement inaugurated at the Paris Congress of 1889, in favour of a universal demonstration for an eight hours' day, on May 1st, has not been without its effect upon the progress of Socialism; in Spain, it has certainly put new life into the Socialist labour party. If international congresses have done nothing else, they have supplied the less organised Socialist parties with a definite programme, and have brought into prominence the growing importance of the Teutonic elements in the movement. This is especially true of the last Congress at Zürich.

Whilst, however, a corresponding priority has been here allowed to the Teutonic countries, it must not be forgotten that the same tendency to seek political influence, and to pursue their ends by political methods, is to be traced in the Latin and, possibly, in the Sclavonic countries, though, as has already been stated, with a difference. Neither in France, Belgium, Italy, nor Spain has the Socialist party passed through the severe course of training to which it has been subjected in Germany and Austria, though such a period may be about to dawn for the Socialism of France. Hitherto French Socialism has

remained both more divided within itself, and more disposed at the same time to exert a terrorist influence over the Government, than the Socialist party in any Teutonic country. The struggle between "Possibilists," or municipal socialists, "Guesdists," or revolutionary collectivists and socialists of distinctly anarchist leanings, has ended in France, according to Dr. Adler, in the predominance of the Guesdist section, which approximates most closely to the principles of Marx and the Germans, whilst encouraging more violence both in action and in utterance. The rather more moderate party of Possibilists, or followers of M. Brousse, like Jules Guesde, a convert from Anarchism, have a strong weapon in their influence upon the municipalities, but, on the other hand, the Guesdists, with their proposal to supplement universal suffrage by the direct reference back to the constituencies of all working-class measures rejected by the Chamber, are prepared to make even greater efforts to gain political power. Before the recent elections, M. Goblet attempted, with some success, to effect an alliance between the municipal socialists and the Radicals, but refused the support of the Guesdists, who were, nevertheless, successful, to a large extent, in the elections.

Belgium has recently witnessed a successful struggle on the part of the Labour, or Socialist party, for a wider franchise; and though the present Italian and Spanish Socialist parties have advanced only a little way in this direction, and are hampered by their connection with revolutionary and anarchist sections, the tendency is still the same. Sclavonic Socialism is as yet scarcely a working-class movement. Both in Russia, in Poland, and in the Balkan Provinces, a large proportion of the Socialists and Nihilists are members of the intellectual proletariat; and Sclavonic Socialism is still several stages behind the Socialism of Latin, and still more of Teutonic countries. It shows itself rather in sudden outbreaks of violence, similar to those which characterised the earlier phases of the Socialist movement elsewhere. Whether the tendency noted recently to enrol a sprinkling of workmen and peasants among its members is to be taken as a sign of growing organisation, and a probable advance upon the lines already traversed in western Europe is a question for the future.

It only remains to notice the latest phase in the Socialist movement. Just as at the end of the second period the Anarchist seceders from the International emphasised the recurring tendency on the part of the younger members of a revolutionary party to pass out of the control of their leaders, the most recent information from almost every country speaks of the rise of a dissentient group within the socialist body. Whether Social Democracy is to become comparatively conservative, or to tend towards revolution, is largely a question of nationality. It is still more largely perhaps a question of the character of the leaders. The conservative influence of a Liebknecht or a Bebel has its limit fixed by nature, and what signs are there of the growth of a similar spirit amongst the younger men? Germany has its "Jungen," with their wrath against "chiefs who have corrupted the old movement of the proletariat," and their derision of a "parliamentary policy which is in itself ridiculous." Austria has its "National" section sympathising with the revolutionary views of the Young Czechs, and not wholly disconnected with secret societies such as the Omladina. It has, again, its "Independents," with their aversion to "party popes" and "parliamentary action." Even Danish and Swedish Socialism have had their difficulties recently with their more advanced members. France, Italy, and Spain complain bitterly of the prejudicial effect produced upon the Socialist movement by Anarchist outrages, less far removed from the principles of the extremer Socialists of these countries than they might be perhaps among Teutonic nationalities. Everywhere there is the same difficulty, and though it is easy to magnify its importance unduly, it can scarcely be regarded as other than a menace to the peaceable advance of the labour movement. It may be urged that the Socialist party of to-day is the labour party of the future, and that the malcontents of 1894 will be the Socialists, or protesters against the social order of a few years hence. The optimism of such a view must, however, be largely tempered by a consideration of the principles formulated by the party already denounced by its antagonists as reactionary, and by reflection on the very small part played as yet by the principles which have hitherto governed the labour movement in Anglo-Saxon countries.

The United States and the Colonies have been omitted up to now in the review of the Socialist movement, because, outside Europe, there scarcely exists a definite Socialist party. The United States has its Socialist Labour Party, founded in the seventies, but this party

is rather academic than popular, and, until its recent activity at elections, came little into public notice. Even now, its vote is insignificant, and it is chiefly noticeable for the socialistic turn which it has given to the minds of labour leaders. Independent political action on the part of labour organisations is now demanded in America; and, just as in Australia, there is a strongly developed tendency towards State Socialism, although there is no definite body of Socialists. Christian or Catholic Socialism is, moreover, a growing force in the States, and there is an increasing demand for experimental legislation, for which the system of government by States and the almost boundless resources of the country offer peculiar facilities. One State is not bound by the example of another, and can afford, therefore, to become an object-lesson in some direction, whilst itself reaping the benefit of others' experience in another direction. At the same time the system has its dangers. It diminishes the feeling of a common life, and the rapid divergence of interests between the skilled and organised labour of the East, and the unskilled and tumultuous labour forces of the West is not the least serious aspect of contemporary American politics. The break-up of the centralised and despotic power of the last head of the Knights of Labour, the Catholic Mr. Powderly, has paved the way for the growing influence of Mr. Gompers of the Federation of Labour, who is trying to consolidate the labour forces of the country upon trade union lines, by allowing a large measure of autonomy to the local branches. Apart, however, from the semi-Chartist condition of the Western States, which appear to offer a promising field to the efforts of Socialist agitation, the organisation of labour in America, as in Australia, and its political influence, have removed the occasion for any such struggle as is waged by Socialism in Europe. Whether this advantage will survive the present fondness for State intervention, and whether the second and third generations will retain the power of self-government won by their fathers are, both here and in England, questions for the future. Meanwhile the dissemination of Socialist doctrines of the more academic type and the popularisation of the Socialist answer to the difficulties of the time, political, social, and religious, deserves attention in English-speaking countries, as much as on the continent of Europe.

The solution which Socialism offers for the labour problem, and for which it claims both completeness and universal application, may be conveniently summarised under the three headings—the Socialist view of property, and consequently of the rightful position of labour in the State; the Socialist view of the proper organisation of society, including the reconstitution of the family; and the Socialist view of religion, or, to put it more broadly, of the moral sanctions likely to influence the action of humanity. The first of these points finds sufficient elucidation in the official programmes of the party; for the second, Herr Bebel's book, "Woman and Socialism," is admittedly an authority; and its very general diffusion is shown by the fact that it has been thought worth while to translate it into almost every European language. The third point assumes peculiar importance when the difficulty becomes apparent of supplying an adequate motive for the restraint upon selfish instincts and the curbing of human passions necessary to ensure the realisation of the Socialist State, and the maintenance of any ordinary standard of decency and morality, under a system that rejects the marriage tie. It remains, however, somewhat in the background of the Socialist programme, and is rather a matter of inference than of statement.

In the first place, Social Democracy demands the entire abolition of private ownership of the means of production. This system has, in the opinion of Social Democrats been the parent of almost every ill which infests the present social order. As the Hainfeld programme has it, "the cause of the present unsatisfactory conditions is not to be sought in isolated political conditions, but in the fact which moulds and governs the whole state of society, that the instruments of labour are monopolised by a few proprietors, The working classes, who have the power to labour, thus become the slaves of the capitalist class, who possess the instruments of labour, and whose political and economic supremacy finds expression in the modern state. Private ownership of the instruments of production, which indicates politically a state founded on class distinctions, signifies economically the increasing poverty of the masses, and the growing degradation of ever widening sections of the population." Consequently, as it is expressed in the Erfurt programme, "Nothing but the conversion of capitalist private ownership . . . . into social ownership, and the substitution of socialist production, carried on by and for society, can effect such a revolution that large industries . . . . can become a source of well-being to

the classes which they have hitherto despoiled." As to the future of property, therefore, the programmes speak with no uncertain sound. They are equally explicit as to the class which is to be benefited. True, they speak of "the community as a whole" and "the abolition of class government," whilst the Erfurt programme declares its hostility to "every kind of exploitation and of oppression, whether directed against class, party, sex, or race." Nevertheless, it is difficult to avoid the conclusion that a party which affirms that the working classes alone are sufficiently disinterested to be entrusted with the task of effecting the social revolution might not find itself wholly devoid of class prejudice when the revolution was effected. Indeed, the Hainfeld programme makes open expression of the intention of "the social democratic labour party" to "represent always the class interests of the proletariat, and to oppose energetically all attempts to conceal the contrast between the classes." If Social Democracy, therefore, or the revolution of the end of the nineteenth century, is to represent the emancipation of the Fourth Estate, just as the revolution at the end of the eighteenth century represented that of the Third Estate, it appears more probable that one form of class government will be substituted for another than that the world will witness the final disappearance of class warfare.

Is the question to be further complicated by attempts to stir up a still more bitter feeling between the sexes? On the face of it, the Social Democratic gospel would deny the suggestion. "Universal equality in rights and duties without distinction of sex," and the "abolition of all laws which place the woman, whether in a private or in a public capacity, at a disadvantage as compared with the man," are the forms in which the Erfurt programme expresses its views on the proper position of women. But the Socialist gospel, as preached by Herr Bebel, has spoken much more plainly. In the Socialist State, the "bourgeois" or "unitary" family, as it is variously termed, is to have no place. The desire for "legitimate" heirs, according to Herr Bebel," is a mere result of the "capitalist" organisation of society, and when that organisation has gone the way of all abuses, it will, he thinks, appear that legitimacy and illegitimacy are terms merely relative to the reasonableness and appropriateness of the relationship between the sexes, which is to be regarded as "a personal matter only." This reasonableness and appropriateness will not include any legal sanction; "only where love is completely free, and the distinction between the legitimate and the illegitimate is abolished, will society witness a return to the true principles upon which the relation of the sexes should be based." The position of the woman, then, in the reconstituted society from which the family has vanished, is to be one of complete freedom. "Equal rights" include "the gratification of every impulse," and liberty "to seek fulness of life in whatever way seems good to her." Though Herr Bebel allows that "the matrimonial union should only be entered upon by two persons inspired by mutual love," he also states that such a feeling is little likely to be permanent, and that the union, if monogamous, will probably be fleeting. Family responsibilities must, therefore, vanish with the "unitary" family; in the socialist state, the children will be a public and not a private care, and the last restraint upon hasty and ill-considered unions will be removed. But it is not suggested that such a social transformation will be effected without a struggle, and a struggle that will involve war between sexes instead of classes. Men are stated by Herr Bebel to be "well content with the present state of affairs . . . . Women have as little to hope from men as the workmen from the middle-classes." They will be obliged, therefore, to wrest the desired freedom from their unwilling "masters," and it is difficult to reconcile such a struggle with anything short of a social upheaval.

What, meanwhile, is to be the place of religion? It is to be a "private matter," for which apparently the Socialist State has no use. When confronted with the enormous difficulty of inaugurating a social order demanding the sternest self-restraint, and the most complete subordination of individual interests to the well-being of the community, socialism falls back upon an appeal to the ideal of humanity. It will have none of the ideal of womanhood, which in the hands especially of the Catholic Church has proved so strong an attractive force to the weakest and least educated, it will have nothing more to say to a Deity except, as M. Leroy-Beaulieu puts it, "to conduct Him to the frontier and thank Him politely for His past services." Doubtless the gradual loosening of the hold of the churches, even of the Catholic Church, upon the working classes, and the widespread acceptance of a cheap form of materialism by the lower middle

classes, especially in Germany, have paved the way for this rejection of the earlier ideals of religion and morality. But even Socialism has not availed to destroy the religious instinct. Of the finer spirits, it can only be said that enthusiasm for humanity may indeed have been substituted for Christianity, but that "they have merely changed their faith, not lost it." To them Socialism, or even Nihilism, has become a religion, "the eldest child of scepticism," and a religion to be embraced with the same fervour as the Catholicism which it has so largely supplanted. To revert once more to the 18th century parallel, the Gospel of Liberty, Equality, and Fraternity, with which that century closed, and which in its turn gave birth to the individualist principle of freedom, has at the end of the 19th century been supplanted by the Gospel of Tyranny, the tyranny of the Socialist order over the individual. At the same time, this new religion, which has to face the problem of how to control the fiercest passions of humanity, and to subdue them to the general welfare, can only replace a definite creed with certain definite sanctions by a vague ideal which, at the best, only appeals to the higher natures even amongst the educated. The very existence of the Socialist State hinges upon the possibility of discovering some sanction strong enough to enforce the Socialist morality; but hitherto the Socialist leaders appear neither to have attempted the discovery, nor to have recognised its necessity.

The immediate aims of Social Democracy, desired as steps towards the attainment of its remoter objects, are necessarily somewhat different in different countries owing to diversity of political and industrial conditions. The tendency, however, to use the phraseology of the party even where it is obvious that such phrases can have no counterpart in fact, produces a singular family likeness among Socialist programmes. It should be noted that the adoption of a definite political platform at all is an advance upon earlier methods. Even German Socialism, prior to 1869, was strongly inclined to reject all proposals for reform within the existing economic order, but increasing wisdom and wider practical experience have apparently convinced the Socialist leaders generally of the desirability of striving for some tangible ameliorations in the lot of the working classes. All programmes give prominence to the demand for universal suffrage and frequently couple it with more frequent elections and the payment of members of Parliament. Direct legislation by the people, popular choice of magistrates, the abolition of a standing army, and the secularisation of religious establishments are constant features in the Socialist demands. Complete freedom of combination is claimed with more or less insistence according to the degree in which it is already enjoyed. A legal eight hours' day is a universal demand, child labour is as a rule to be prohibited, but the more advanced of the programmes repudiate the protective legislation for women which appears in the less advanced on the ground that it is likely to impair their economic equality with men. Free secular education, improved factory inspection, and compulsory provision for the sick and aged, as well as for the unemployed are the chief remaining demands, and the German programme proposes to raise the funds needed for all public expenses by imposing a graduated income-tax and succession duty and at the same time abolishing "all indirect taxation, customs duties, and other economic measures which sacrifice the interests of the community to the interests of a privileged minority." Claims for a minimum wage to be fixed by the State are not infrequent, but as a rule the method to be adopted is not further particularised, nor is it stated how "the right of every citizen to remunerative work" is to find its practical recognition.

In so far as Social Democracy has become a strong and well-defined party with an elaborate organisation and a detailed political programme, it can be clearly distinguished from the spasmodic revolutionary movement conducted by the Anarchists. The great care taken by the Social Democrats to dissociate themselves from their Anarchist followers has been exemplified in a striking fashion at the recent international congresses. The Paris Congress bore with the Anarchists until they disturbed the debates, the Brussels Congress included "a recognition of the advantages of political action and State intervention" amongst the necessary credentials, and so got rid of the few anarchist representatives. A similar policy was adopted in 1893 at Zürich, though here the ejection of anarchist pretenders was not accomplished without recourse to force. But however hotly Social Democracy as a whole may repudiate Anarchism, there are not wanting individual Social Democrats who supply the necessary connecting link. Nor is the time far distant at which Anarchists were tolerated within the Social Democratic

ranks; in Austria they occupied prominent positions as recently as 1884. It has already been shown that the International Association, which occupied such a conspicuous place in the second period of Socialism, brought to the front, in its decadence, the underlying anarchist tendencies, as well as the exaggerated individualism which lie close to the extremer forms of Socialism. It has also been shown that these extremer forms have lately shown a tendency to reassert themselves and to rebel against the authority of the Socialist leaders, and it is, perhaps, not without significance that the end of the third period of Socialism has been marked by a series of Anarchist outrages not confined to any one country, though most frequent in France and Spain, where Socialism has been most aggressive in its methods. The treatment accorded to the Chicago Anarchists has apparently checked any acceptance of Anarchist propaganda in the United States, and the attempts of Most to discredit the German Social Democrats have had small success in view of the ceaseless efforts of the German leaders to stamp out Anarchist principles and practices amongst their followers. Austria has had greater difficulties; the Latin countries are still the scene of numerous Anarchist attempts, and Russian Nihilism, though for the time quiescent, may at any moment break out into "propaganda of deed." In view of the ever-present danger to society arising from Anarchist groups, it is interesting to note the attitude of the various Governments. The stern repression of Anarchists and Socialists alike by the German Government has been so recently relaxed as apparently to have gone far to crush the dangerous elements; Austria, which allowed the anti-Anarchist law to lapse, seems likely to require fresh powers; Italy has had to put down a revolutionary Socialist movement by military force, and has passed an anti-anarchist law; Spain has made wholesale arrests amongst Anarchists; and France, after permitting a degree of liberty almost amounting to license, has suddenly adopted an opposite course, and has obtained special powers from the Chamber of Deputies, which recall the severest regulations of the German Government. Even the United States Senate has introduced a special law to prevent the immigration of foreign Anarchists. Everywhere, however, the Anarchists seem to be formidable rather by reason of their peculiar methods than by reason of their numbers. Although it is difficult to obtain any exact information, there seems little ground for supposing them numerous or powerful; nor does it appear, as yet, that the countries with a strong Government and an efficient police have much to fear from their activity.

Though the character which the socialist movement assumes in different countries appears to an impartial observer largely a question of nationality, Socialism itself has, almost from the outset claimed to be regarded as international. The watchword of Marx, "Proletarians of every land, unite," has been the motto of the party ever since the issue of the Communist Manifesto of 1847. The gradual supplanting of the Lassallian or national Socialists of Germany by the Marxist party, and the subsequent influence exercised by that party over European Socialism generally would, even apart from the International Association of Working Men, have sufficed to give the movement an international character. Its internationalism, however, remains rather a matter of theory than of practice. The social Democrats of Germany may, as their latest programme puts it, "feel and declare themselves at one with the workmen of every land," but when the Zurich Congress proposed a general strike in the event of a declaration of hostilities, Herr Liebknecht, on behalf of his party, repudiated the suggestion on the ground that any such action on the part of Germany would be to place Europe at the mercy of Russia. In 1870, the national enthusiasm aroused by the successes of the German army was sufficient to check the growth of the International, just as in 1893 the popular excitement caused by the advent of the Russian admiral in Paris, entirely overshadowed any attempt to arouse sympathy for the miners on strike. Nor is patriotic fervour the only effective barrier against genuine internationalism. National jealousy, and the ingrained inclination to protection on the part of the working-classes, adds another obstacle to the formation of an international and united proletariat. The hatred felt by the German workman for the Pole, and by the French peasant for the Italian immigrant appears likely to survive the acceptance of the Socialist gospel. At present, it might almost be said that the Anarchists are the only internationalists, and that their internationalism finds its basis in a common hatred to every form of constituted authority. Socialism, far from being international, seems to bring out into striking relief the contrast between nationalities. Whether the comparative conservatism of the Teutonic form, or the revolutionary

tendencies of the Latin and Sclavonic are to determine the future of the European labour movement, and whether either or both are to modify the Anglo-Saxon self-governing institutions of America and the Colonies, becomes more and more a question of the future distribution of population, and a question, therefore, which could only receive an approximate answer after a review of the various factors which determine that distribution. Such a review is impossible within the limits of this paper, but was partially attempted in a paper which I read before the Royal Statistical Society on December 18th. In the meanwhile, it is suggested, for the serious consideration of the student of social problems, that between the principles and practice of Continental Socialism and the most recent utterances of English Socialism, there exists a resemblance which may well give pause to a lover of freedom and a lover of his country. Are we to see an increase in bureaucratic control and a decrease in the sphere of voluntary effort? Are we to be governed, or to govern? Are the forces which make for character, the training of associative effort, the struggle to gain the one step higher, the joy of individual success, to give place to the deadening influence of the Socialist State? Or if Socialism poses successfully as a prophet of good tidings, will it declare its message with no uncertain sound, and is that message identical with the gospel of Continental Socialism given above? To these and similar questions, the working-men and women of England await the answer, and upon the nature of that answer depends the future of the labour movement.

DISCUSSION.

Mr. MARTIN WOOD said his impression was that the subject of the paper was to be labour in connection with the colonies, but, from what he had heard, it seemed to be mainly a denunciation of Socialism, and to contain rather more of a political nature than was usual in that Society. He thought nothing would be more useful than an attempt to discriminate between Socialism and those economical principles which were sometimes confounded with it, as it was one of the artifices of Socialist writers to confuse with their schemes the more extended principles of economics; but he found no such attempt at discrimination in this paper.

Mr. W. G. TREWBY said the paper seemed to be devoted mainly to the question of what movements were operating amongst different labour bodies, and who were the persons who were exciting those movements. He gathered from the paper what had been long known, that the Roman Church, failing to galvanise any life into itself in certain countries, was simply smashing the machinery; and failing to act on the intellects of the employers, it was inciting the labourers to a struggle with them. When the writer took up simply the question of the action of Socialists and Anarchists, he was going far beyond the question of labour. He (Mr. Trewby) regarded those men as simply in the front rank of selfish politics; they had nothing to do with labour; they were simply striving to make a place for themselves by climbing on the shoulders of the workers.

Mr. R. NIVEN thought the paper contained a very careful and exhaustive statement of the facts, both in Europe, Australasia, and America; but he ventured to think it was much too *doctrinaire*, and he found very little trace of any really first-hand study of the facts. He thought the writer would have done a much greater service if he had gone to work in a somewhat different way. If Mr. Drage or the Society wished to obtain satisfactory data, on which people could form their own conclusions, a few men should be selected, from all political parties, and sent out one to each colony in Australia, and the Cape, to Canada and the States, and let them collect information on the spot, and send it home and it might then be used in confidence to base conclusions upon. Mr. Drage seemed to think it a very easy thing to define Socialism, but he ventured to say it was impossible to do so for practical purposes. Socialism ranged from the most innocuous and helpless thing to the most absurd and insane, bordering on anarchy.

The CHAIRMAN thought this was a question which had received somewhat less attention here than in other countries, and perhaps less than it deserved, especially at a time when large numbers of our own people were looking to some of those changes to which Mr. Drage had adverted as a remedy for existing evils. It was very desirable that their attention should be drawn to the fact that labour questions existed to the same, perhaps even to a much greater extent in other countries than they did in England, and that very various remedies were proposed. He did not think he differed in any material points from the conclusions at which, as he understood the paper, Mr. Drage had arrived, that neither State intervention, so far as it was being brought into play, nor the action of the great religious bodies, nor the efforts of private benevolence, had hitherto afforded any more satisfactory solution of social difficulties than that which had, to a very considerable extent, been brought about amongst ourselves by what he had termed the self-governing solution; by which he took him to mean associations and combinations amongst working men themselves. He probably wished to impress upon

them that not only had no solution been arrived at by those methods which had been tried, but that no better solution was offered by those socialistic doctrines which were accepted by a large number of people in other countries, and, to some extent, at home. No doubt, as education spread, and facilities for discussion were increased, larger numbers even of the great labour associations might be led to look to Socialism and allied doctrines as a remedy for the evils under which they still laboured; but his own belief was that trade unionism was an institution essentially in harmony with the traditions and character of the English people, and with the self-governing institutions which had so long existed amongst us. He also believed that the spirit of trade unionism was not favourable to Socialistic doctrines, and though these might for a time acquire some following amongst the individual members, such doctrines would eventually be found to be antagonistic to the aims of the associations, and would be discountenanced. He concluded by proposing a vote of thanks to Mr. Drage.

The vote of thanks was carried unanimously, and the meeting then adjourned.

Miscellaneous.

SALT MINES OF THE PUNJAB.

The range of the salt hills of the Punjab extends from the town of Thelum eastward to Kalabagh on the Indus. There is a salt range extending beyond Kalabagh, across the Indus, but the salt is of a different age and position. Khewra is the name of the village where the most important of the mines are worked. These are called the Mayo salt mines, in honour of Lord Mayo, who visited them when Viceroy of India. The only inhabitants of Khewra are those whom the work connected with the mines renders necessary; but a railway makes communication with Thelum and Lahore easy. A recent report from India states that the depôt where the salt is collected and despatched is called the Warthgarj depôt. The Mayo salt mines are not mines in the sense of being far beneath the surface of the ground—like a coal mine, for instance. At the base of a high, ragged hill there are two or three openings, like the mouths of tunnels, and through these tunnels the visitor may walk or be carried on trollies, accompanied and guided by miners with torches and little earthen saucer lamps, called *dhivas*, to light up the encircling darkness. When the visitor overcomes the first sensations of novelty and bewilderment, he looks round and sees nothing but salt, salt roof, salt floor, salt walls, all blackened and begrimed with the soot from torches and *dhivas*. Sometimes, at short intervals, large recesses, called "stations," where salt ready for removal is collected, are met with. The salt is rock salt, and is obtained first by blasting and then by cutting with a rough pick. The miners are so accustomed to the work that the little *dhivas* are all the light they require, and the neatness and regularity with which the walls of the chambers are cut are remarkable. These chambers are immense rooms; one of them being 320 feet long and 150 feet high. The salt obtained is generally of a pink colour, sometimes of a dirty or muddy pink. Natural salt is said to be found in almost every colour—red, brown, green, blue, &c.—but at Khewra the prevailing colour is pink; the transparent crystal salt is also found. A solid, rectangular block of 37 cubic feet, and weighing two tons, was sent to the Vienna Exhibition of 1873. The quantity of salt in the Khewra range is said to be practically inexhaustible. It has been calculated that if an average thickness of only 135 feet and a width of three miles be assigned to the salt beds, then, in the 130 miles along which these are seen, there may be 130 miles by 3 miles by 135 feet of beds, giving as the solid content of the salt deposits nearly 10 cubic miles. As for the quality, it has been stated that the salt is of a purity such as few salt mines of the earth can yield.

IMPORTS OF FROZEN MEAT.

The following Tables show the amount of importations of Australasian frozen meats since the initiation of the business:—

AUSTRALIA.

Year.	Consignments.		Number of Shipments
	Carcases Mutton and Lamb.	Pieces of Beef.	
1880....	400	a quantity	1
1881....	17,275	1,373	6
1882....	57,256	1,033	13
1883....	63,733	753	16
1884....	111,745	2,359	27
1885....	95,051	6,040	26
1886....	66,960	5,796	19
1887....	88,811	17	19
1888....	112,214	1,334	26
1889....	95,716	14,201	18
1890....	208,314	14,984	37
1891....	335,192	28,586	37
1892....	505,024	45,250	42
1893....	640,153	163,022	52
1894....	930,961	178,995	63
Total ..	3,328,805	463,773	402

NEW ZEALAND.

1882....	8,839	..	2
1883....	120,893	728	15
1884....	412,349	1,725	39
1885....	492,269	11,916	38
1886....	655,883	16,264	40
1887....	766,417	6,973	38
1888....	938,766	25,888	45
1889....	1,068,506	42,722	48
1890....	1,531,901	55,659	58
1891....	1,892,271	68,975	67
1892....	1,539,487	35,720	59
1893....	1,895,546	8,408	57
1894....	1,963,308	1,131	58
Total ..	13,286,440	276,109	564

Correspondence.

TEA.

Mr. R. GORDON SHAW (88, Bishopsgate-street, Within, E.C.) writes:—Sir Henry Peek appeared to think that China tea is more beneficial to health, because it contains less tannin than Indian tea; and while various speakers who followed him endeavoured to palliate this assertion, it does not seem to have occurred to any of them to assert that a cup of Indian tea contains less tannin than a cup of China tea. Yet the figures brought forward that evening—figures that I have not heard disputed—show this conclusively.

The analyses quoted by Mr. John Hughes are—

Assam tea, 5 minutes infusion, tannin 10·35
China ,, ,, ,, ,, 7·80

But the Customs authorities, whose verdict was quoted by the lecturer, endorsed by him, and according to him, by the British housewife, shows that 1 lb. of Indian tea makes as much again of liquid tea as 1 lb. of China—say $7\frac{1}{2}$ gallons against 5 gallons.

If then you divide 10·35 by $7\frac{1}{2}$, = 1·38, and 7·80 by 5 = 1·56, it is evident that a cup of China tea infused five minutes contains ·18 per cent. more tannin than a cup of Indian.

General Notes.

PRIZES OFFERED IN CONNECTION WITH THE GAS INDUSTRY.—The Société Technique de l'Industrie du Gaz en France offers, in connection with the Congress to be held during the present year, several prizes, some of which are restricted to the members, while others are open to all, whether Frenchmen or foreigners. A sum of 250 francs (£10) will be awarded to each of the authors of the best communications made to the Congress, and one or more prizes of 200 francs (£8) will be granted to foremen or workmen who have rendered long and continuous service at the same gasworks represented by a member of the society. The prizes open to all include one of 10,000 francs (£400) offered to the inventor of an incandescent gas-burner showing marked superiority, to be handed in to the society before the 1st of April in the present year, unless the committee exercise their power of extending the period for another year. The sum of 8,000 francs (£320) will be devoted to various prizes to be awarded to the authors of the best papers on some subject connected with the gas industry, such as the mechanical *manutention* (handling) of coals, cokes, and the various substances used in gasworks, a study of water-gas, and the substitution of hydro-carbons for cannel coal. The number and value of these prizes will be determined according to the importance of the papers deemed worthy of that honour. The papers must be written in French, and not bear the name of the author; but they must contain at the commencement a motto, which must be reproduced on a sealed envelope containing a declaration, signed by the author, that his work is unpublished, and that he will not make any other publication on the same subject within a year. The manuscripts, with sealed envelope, must be sent to the society, 65, Rue de Provence, Paris, at least forty days before the period fixed for the Congress.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 13.—"Light Railways." By W. M. ACWORTH. SIR BENJAMIN BAKER, K.C.M.G., F.R.S., will preside.

FEBRUARY 20.—"Rule of the Road at Sea." By ADMIRAL P. H. COLOMB.

FEBRUARY 27.—

MARCH 6.—"Cider." By C. W. RADCLIFFE COOKE, M.P. SIR GEORGE BIRDWOOD, K.C.I.E., will preside.

INDIAN SECTION.

Thursday Afternoons, at Half-past Four o'clock:—

FEBRUARY 14.—"Village Communities in Southern India." By C. KRISHNA MENON, Lecturer on Agriculture at the Sydapet College, Madras. SIR CHARLES ARTHUR TURNER, K.C.I.E., will preside.

*** This meeting will be held at the Imperial Institute, S.W.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 19.—"Paraguay." By A. F. BAILLIE, Consul in London for Paraguay. LIEUT.-GENERAL SIR ANDREW CLARKE, G.C.M.G., C.B., will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

FEBRUARY 26.—"Mediæval Embroidery." By MRS. MAY MORRIS SPARLING. ALAN S. COLE will preside.

CANTOR LECTURES.

Monday Afternoons, at Four o'clock :—

ALAN S. COLE, "Means for verifying Ancient Embroideries and Laces." Three Lectures.

FEBRUARY 11.—LECTURE I.—Sources from which may be taken indications of ornament in textiles ascribed to Egyptians, Assyrians, and other kindred Oriental people—Actual embroideries from 1000 B.C.—Distinction between embroideries and weavings—Three broad classes of embroidery, and the antiquity of them—Climate as affecting the use of materials—Linen and wool chiefly used by Egyptians, Assyrians, and Greeks—The darning or inweaving method of embroidery predominant with them—Its development later as a weaving process—Gold thread employed with coloured threads in the darning embroideries—Examples of ornamented textiles from early Egyptian paintings—Patchwork a notable method with Egyptians and Assyrians—Examples of Assyrian and Persian embroideries.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. (Cantor Lectures.) Mr. Alan S. Cole, "Means for Verifying Ancient Embroideries and Laces." (Lecture I.)

Scottish Society of Arts, 117, George street, Edinburgh, 8 p.m. 1. Committee's Reports on (*a*) Mr. Ireland's Paper, "A New Net-making Machine;" (*b*) Mr. M'Donald's Paper, "An Adjustable Boot-Tree;" (*c*) Mr. Kirkwood's Paper, "A Sun-Dial Protractor." 2. Mr. Robert Meldrum, "Recent Advances in the Education of the Blind, with special reference to their Methods of Communication with each other, and with the outer world." 3. Mr. H. M. Cadell, "A New Implement for extracting Thistles."

Imperial Institute, South Kensington, S.W., 8½ p.m. Rev. W. T. McCormick, "Across Iceland on Horseback."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. H. Dennis Taylor, "A Simplified and Improved Form of Photographic Lens."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Professor Victor Horsley, "Truth and Falsehood as to Electric Currents in the Body."

TUESDAY, FEB. 12...North-East Coast Institute of Engineers and Shipbuilders, Literary and Philosophical Society's Rooms, Newcastle-on-Tyne, 7½ p.m. 1. Mr. F. Caws will reply to the discussion on his paper, "Ship Acceleration and Fluid Resistance." 2. Discussion on Mr. W. C. Mountain's paper, "The Design and Efficiency of Plant for the Transmission of Power by Electricity." 3. Mr. Henry Foster, "The Application of the Electric Arc to Machinery, Boiler Repairs, &c."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "Internal Framework of Plants and Animals." (Lecture V.)

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. R. T. Hewlett, "Elementary Bacteriology."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on paper by Mr. John Richardson, "The Mechanical and Electrical Regulation of Steam-engines."

Photographic, 50, Great Russell-street, W.C., 8 p.m. Annual Meeting.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. E. W. Brabrook, "The Ethnographic Survey of the United Kingdom." 2. Mr. A. L. Lewis, "Prehistoric Remains in Cornwall." (Part I.) 3. Mr. John Beddoe, "The Northern Settlements of the West Saxons."

Colonial Institute, Whitehall-rooms, Whitehall, place, S.W., 8 p.m. Hon. H. T. Whitehead, "The Critical Position of British Trade with Oriental Countries."

Asiatic, 22, Albemarle-street, W., 3 p.m.

WEDNESDAY, FEB. 13 ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. M. Acworth, "Light Railways."

Sanitary Institute, Parkes Museum, Margaret-street, W., 8 p.m. Discussion on "Dry Methods of Sanitation," to be opened by Dr. Vivian Poore.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, FEB. 14... SOCIETY OF ARTS, 4½ p.m. (Indian Section.) Mr. C. Krishna Menon, "Village Communities in Southern India." This meeting will be held at the Imperial Institute, South Kensington.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. C. F. Binns, "Glass: Antique and Artistic."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. L. Fletcher, "Meteorites." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. W. B. Sayers, "Reversible Regenerative Armatures and Short Air-space Dynamos."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8 p.m.

Civil and Mechanical Engineers, 12, Delahay-street, Westminster, S.W., 7 p.m. Mr. E. H. G. Brewster, "Waste preventing Cisterns."

FRIDAY, FEB. 15.—Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. Clinton T. Dent, "Mountaineering."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. J. Castell-Evans, "Physics and Chemistry." (Lecture IV.—Wales.)

North-East Coast Institute of Engineers and Shipbuilders, St. Nicholas-buildings West, Newcastle-on-Tyne, 7½ p.m. 1. Discussion on Mr. Bowden's paper, "Railway Brakes." 2. Discussion on "Indicators and Indicator Diagrams," to be opened by the Chairman, Mr. A. Lindsay Foster.

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m. Annual Meeting.

Geological, Burlington-house, W., 8 p.m. Annual Meeting.

SATURDAY, FEB. 16 ... Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander Campbell Mackenzie, "English Country Songs."

Journal of the Society of Arts.

No. 2,204. Vol. XLIII.

FRIDAY, FEBRUARY 15, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday afternoon, 11th inst., Mr. Alan S. Cole delivered the first lecture of his course on "Means for verifying Ancient Embroideries and Laces."

The lectures will be printed in the *Journal* during the summer recess.

PRIZES FOR PHOTOGRAVURE.

With the view of encouraging the development of Photogravure in this country, the Society of Arts offer the following Two Prizes:—

(1). A Prize of Twenty Pounds or a Gold Medal* for the best reproduction of a selected picture by a Photogravure process.

(2). A Prize of Ten Pounds and a Silver Medal for the best Photographic Negative of a selected picture, suitable for reproduction by a Photogravure process.

The following are the conditions of the offer:—

The offer is limited to British subjects.

The Committee have selected as a suitable test picture, Mulready's "Choosing the Wedding Gown," now in the South Kensington Museum, and the Lords of the Committee of Council on Education have kindly consented to allow the picture to be used for the purpose.

Competitors will be allowed to photograph the picture, which will be placed for the purpose in the Photographic Studio of the Science and Art Department.

Competitors should apply to the Secretary of the Society of Arts, who will provide them with an order to photograph the picture, and will also see that the necessary arrangements for the purpose are made. Such applications must be received not later than the 30th March. A dark room is attached to the studio so that competitors can develop their plates on the spot.

Competitors for Prize No. 1 will be expected to send in a finished proof from the plate, the plate itself, and the negative from which the plate was made.

Competitors for Prize No. 2 will be required to send in the negative and a print from it. (This print may be in silver, carbon, platinotype, or other process.)

The negatives for both prizes must be taken on plates 12 × 10 inches, and the finished picture must be of corresponding size. The actual size of the original without the frame is about 21 × 18 inches.

The photographs and photogravures must be wholly untouched. Any work on the negative or plate will be held to disqualify the competitor.

The prints, plates, and negatives must be sent in to the Society of Arts not later than the 15th of May next.

The winner of Prize No. 1 will not be disqualified for Prize No. 2.

The photographs, negatives, and prints will be returned to the competitors after the decision of the judges has been announced, but the Council of the Society reserve to themselves the right of exhibiting all or any of the works sent in.

The judges will be the Committee nominated by the Council:—Major-General Sir John Donnelly, K.C.B., Chairman of the Council; Sir Frederic Leighton, Bart., P.R.A., H. T. Wells, R.A., E. J. Poynter, R.A., Francis Cobb, Thomas Armstrong, Capt. W. de W. Abney, C.B., F.R.S., and Sir Henry Trueman Wood, Secretary.

The Council reserve to themselves the right of withholding either or both of the prizes, or of awarding smaller prizes, if they think it desirable to do so. The Council also reserve the right of declining to accept, at their discretion, any application for orders to photograph the picture.

The Council will not be responsible for any loss of, or damage to, works sent in.

* Should the winner of the prize elect to take the award in money, a Silver Medal will be given in addition to the sum of Twenty Pounds.

Proceedings of the Society.

INDIAN SECTION.

Thursday, January 31, 1895; Major-General Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., in the chair.

The CHAIRMAN, in opening the proceedings, said:—The Society of Arts undertakes and ably carries out work which entitles it to the warm acknowledgments of all Englishmen; but no part of its work is more important or interesting than that which provides instruction in the social and industrial life of the various parts of the British Empire. This afternoon we have a paper on "India and its Women," by Mr. S. E. J. Clarke, of Calcutta. This gentleman is an old and much respected resident of that city, and is well known to many as secretary of the Bengal Chamber of Commerce. As an intelligent and trusted adviser of some of the leading native families in Bengal and elsewhere, he has enjoyed unusual opportunities of making himself acquainted with the customs and home life of the majority of our fellow subjects in India; and all who know him will recognise in him an accurate and trusty observer. As the desire of the Society of Arts is to obtain information on these questions "up to date" from men whose knowledge is unimpeachable, I think we are fortunate in having obtained a paper on so interesting a subject from so competent a man as Mr. Clarke. I regret to say that he is not himself in England, but the paper will be read for him by Sir Alexander Wilson, who is well known to us all as one who has done much good work in India and elsewhere.

The paper read was—

INDIA AND ITS WOMEN.

By S. E. J. CLARKE.

INTRODUCTION.

Nothing to a student of India is more noteworthy than the close and clear knowledge possessed by the men who helped to found the British Indian Empire, of the condition and circumstances of the Indian peoples. They convince the student that the founding of the empire was not a mere chance, or the mere turning of opportunities to account. The men who assisted in that mighty task knew what they were doing, and proceeded upon a fulness of knowledge, for the like of which we look in vain in this generation. Sir William Hunter may be quoted in proof of the position here advanced. He has shown that, in making the permanent settlement in Bengal, Lord Cornwallis, Sir John Shore, and the officers upon whom they relied, possessed an abounding and detailed knowledge which their critics and detractors have wholly failed to rival, if not, indeed, to comprehend.

MISCONCEPTIONS.

Few subjects connected with India so illustrate the general and prevailing ignorance of Indian matters as the remarks usually heard about Indian women. Their condition is commonly described as most melancholy and miserable. They are represented as cut off from what may be termed those ordinary pleasures of life inseparable from the performance of its ordinary duties. We are told that, by the pride or jealousy of man, they are reduced to a condition where it would be perhaps happier if they were actually slaves. Few appeals are so powerful in the ears of English men and women as those made on behalf of the downtrodden and cruelly-treated Indian women; yet, just as in 1696 we find one feature of the silver question touched upon by Dr. Davenant, in his "Essay upon the East India Trade," in the following words, "Europe draws from thence nothing of solid use—materials to supply luxury, and only perishable commodities—and sends thither gold and silver, which is there buried, and never returns," so nearly a century later, in 1778, we find Mr. John Richardson, in his "Dissertation on the Languages, Literature, and Manners of Eastern Nations," thus stating the general proposition as to women in the East:—

> "Travellers, in general, do not appear to have conceived a just idea of the situation of women in many Eastern countries. They are, for the most part, considered by them of small importance in the State; they are represented as mere slaves to the passions of the stronger sex; and, because great men keep many beautiful Circassians locked up from public view, a proper distinction does not seem to have been made between them and free-born women. But an attention to the languages and customs of Asia will give us reason to believe that such indiscriminate observations are partial, superficial, and inconclusive."

This reproach practically sums up the indictment which may be brought to-day against those who deplore the condition of the women of India, because they do not follow the customs and modes of living familiar to Western nations. Yet what was said of them by the Abbé Dubois, in 1817, holds good to-day that—

"A woman may go wheresoever she pleases. She may walk in the most public places—must I except those where the Europeans abound—and having nothing to fear from libertines, numerous as they are in the country. A man who should stop to gaze on a woman in the street, or elsewhere, would be universally hooted as an insolent and most low-bred fellow."

It must not be supposed from this that women are free to roam the streets at their own sweet will, nor must the Abbé's contrary statement that they live a degraded life be accepted as true in their sense. They live their own lives according to long-descended customs, and in obedience to ancient but well-understood laws. Amongst ourselves, laws to govern the conduct of women may be wanting, but there are laws imposed by well-known, universally understood, but unwritten customs, which are as binding and as full of restrictions as the written laws of India. If their mode of life be strange to us it must not be forgotten that our manners and customs are just as strange to them, and not only strange but repugnant. To them the freedom enjoyed by English women would be deemed a degradation indeed, a wilful abandonment of the sex to dangers and temptations from which it is man's duty—in their view, one of his highest duties—to protect them. If I can present to you this afternoon another side of the picture it may serve perhaps to awaken in you a keener and deeper interest in the great empire, and in the people of India; a people of whom it has been most justly remarked :—

"A certain nation exists, cultivated from the earliest ages, the only one perhaps in the universe, which has never sunk into barbarism, and which, of all ancient nations, may most deserve to fix the attention of the philosopher; one which attracted the admiration of antiquity by its successful cultivation of the sciences and arts, and by the admirable system which it invented for the maintenance of subordination in the community, as well as of good order in private life. This nation spread its renown over the whole extent of polished antiquity, compelled the most enlightened of all people to confess its pre-eminence by alluring into its bosom the wisest of the philosophers of Greece. These, in spite of their pride and high pretentions, did not feel degraded by pursuing a long and dangerous journey into India to consult the wisdom of its Brahmans who had flourished there in long succession, and to acquire from them a knowledge of philosophy and the sciences which they had cultivated until their fame extended even into Europe. How wonderful, then, that such a nation remains almost unknown to the Europeans who dwell in the midst of it, and who bear rule over a large portion of its soil!"

These words were written in 1817, yet everyone must admit they can be repeated today with a justice amounting almost, so far as England is concerned, to a national reproach. I would that every English boy and girl should be specially taught at school not only the facts of the history of India, but the peculiarity of its manners and customs, an outline of its religion, and to understand its peculiar and marvellous system of caste. Sure I am that the spread of knowledge can only result in honour to England and in better government to India; sure I am that no people in the world are so anxious to be understood and appreciated by another and a stranger people as the people of India by the people of England; their heart is with England and its people, and if there is to them any bitterness in the connection they nobly seek to make excuse by ascribing mistakes to ignorance of their needs, and wishes, and requirements, and by hoping and longing yet more strongly for that comprehension and understanding between them and Englishmen which is a necessity, if the rule of Britain in India is to be maintained, and maintained for the good of both peoples.

Great Part of Women in History.

Europe is familiar with the great part in its progress and development fulfilled by great women. Here in Britain, at the very threshold of our history, we have the splendid figure of the patriot Queen Boadicea, who, with her daughters, led her nation in its fight for liberty. All through the long and glorious pages of our island story we have a roll of women in no way unworthy to take their place by the side of the great warriors and wise statesmen of whom, as a race, we must be proud; a roll illustrated by such a name as Elizabeth, and ending for us with that of the gracious and great Sovereign, yet noble and tender woman, Victoria. So in the East there never has been a time, and there never has been a generation in any Eastern country, without some great woman stepping forward to prove by splendid qualities of head and heart the dignity, the virtue, and the mission of the sex. India has been in a special way renowned for its famous women. Far back in the dim past there shines out the heroic figure of Draupadi; the womanliness of Sakantala and Damayanti. In the early days of Mahom-

medan supremacy a woman, Sultan Rezia, ruled at Delhi, and manifested an administrative capacity which has given her a special place in the annals of the empire of which Delhi was the centre and capital. Coming to times nearer our own, what shall we say of the way in which that lovely maiden, Princess of Udaipur, tracing her descent far back to the Avatar, Rama, who willingly accepted her devotion to death that war might cease and peace be restored to the people whom she loved? What are we to say of Munnee Begum, who, by her far-perceiving wisdom, did so much to assist in placing English rule on a firm footing, and earned for herself the title of "Mother of the Company"? What are we to say of that Rani of Jansi, who died under the sabre of an English trooper, fighting with more than the gallantry of a man for what she believed to be her rights and the independence of her countrymen? However much we may condemn her cruelty and fierceness, we must give her, as one of the bravest of our enemies, her due in that she did not sit idly down and lose herself in lamentation, but shared the risks and perils of those she called to war, and, to the last, set them an example which must, and will, in quieter times, give her a just place amongst famous women.

Our own Times.

War has now ceased out of the land, peace reigns supreme, and calls upon the women of India for other duties than the showing of men how to fight or how to govern. And what do we find? A State like Baroda redeemed from misgovernment by the wisdom and energy of a woman ruler—the Rani Jumna Bai. We find Indian women gathering praise on all sides for their charities. Maharani Surnomoyee, in Bengal, sets an example which is unostentatiously followed by a crowd of noble native ladies, who in their lives and in their kindly ready charity—a charity which ignores distinctions in its objects—illustrate for us the stories which have come down to us of the high position occupied by the womanhood of India. This position they have gained owing to their natural aptitudes and in spite of dogmatic injunctions in some of the sacred books which, if taken literally, would go far to make a woman's position amongst the Hindoos scarcely bearable, and would practically destroy the beauty of that home life so highly prized amongst the people and of such infinitive use to them in all their concerns. For instance, a woman may obtain salvation but she does not obtain it as a matter of right or as on equal terms with her husband. Yet, the women of to-day are distinguished for their intense religious feeling; they are the guardians of the Hindoo faith, they have withstood the spread of indifferentism, and have maintained for more than a generation such a hold upon religion as to have overcome the tendency of the men to drift away from their national faith, and they now see a strong and deep-flowing current of opinion setting steadily in a marked return on the part of the men to religious subjects and speculations. It is not too much to say that it is in the work of the women of India that Hindooism has found its greatest and sustained protection. To Hindoo women religion is a real governing principle of daily life and of every action. That it should be so can be easily understood when we consider that the life they lead excludes them from the operation of disturbing causes. They hear from the men what goes on in the world and may hear from them arguments against this or that dogma, but these arguments cannot be addressed to them directly and are almost certainly presented to them in a form deprived of the strength of the original discussion.

Ancient Opinions and Marriage.

Whilst then the precepts of Menu and others aken by themselves, would present the life of Hindoo women as an unbearable tyranny on the part of men, a tyranny based on sacred laws, we find Krishna, in the tenth chapter of the "Bhagavadgita," declaring that he is "Among females, fame, fortune, speech, memory, intellect, courage, forgiveness!"—that is, that these qualities are feminine amongst the qualities ascribed to the deities, and being specially feminine we may take them to indicate qualities appropriate to women. The very earliest books in Hindoo literature speak of "a well-dressed wife," "an irreproachable and beloved wife," "a wife who ornaments the chamber of sacrifice and adorns the dwelling." Family concord was highly prized; the Athurva Veda represents the husband and wife as "both rulers of the house." The women are represented as holding social meetings and conversing on an equality with their husbands and with men of cultivated intellect; husbands and wives went together to attend to the sacrifices; maidens attended in processions; and grown-up unmarried daughters remained in their fathers' houses. Women had a claim to a share in the ancestral property. Indeed we are told that

"a daughter is equal to a son." Then, as now, marriage was a specially religious ceremony; the idea of a civil union, or a civil contract of marriage, between the sexes is hostile to the Hindoo's conception of a home and repugnant to his ideas of what a marriage ought to be; for a Hindoo wife may save her husband, or increase the evils for which his soul must do expiation. In choosing a wife a man in modern times is restricted to certain families. One of the Shastras lays down that the bride must not be descended from the bridegroom's paternal or maternal ancestors within the sixth degree. If the family is eligible the bride may be taken though her parents be not rich in kine, goats, sheep, gold or grain; she must have no defect of form, and must be one "who has an agreeable name, who walks gracefully like a young elephant, whose hair and teeth are moderate respectively in quantity and size, and whose body has exquisite softness."

Beauty.

In the "Shiva Puran," Sharuda, the daughter of Brahma, is thus described :—

"She was of a yellow colour, had a nose like the flower of the sesamun, legs taper like the plaintain tree, eyes large like the chief leaf of the lotus, eyebrows which extended to her ears, lips red like the young leaves of the mango tree, a face like the full moon, a voice like the sound of the cuckoo, arms which reached to her knees, a throat like that of a pigeon, loins narrow like that of a lion, hair which hung in curls down to her feet, teeth like the seeds of the pomegranate, and a gait like that of a drunken elephant or a goose,"

I think I hear many of you exclaim, "What a beauty!" But beauty is by no means uncommon amongst the women of India. In Bengal the women are, as a rule, smaller than the women of Upper India, but differing as they do in degree for beauty of form and face, for intelligence and grace combined the women of India may challenge comparison with their sisters in any part of the world. In the North-Western Provinces and Rajputana, where what is called the Aryan race has maintained its purity, the women are exceptionally lovely, and seeing them we can understand why Mogul emperors should have named their wives Noor Mahal—"the Light of the Palace," and Noor Jahan—"the Light of the World." If we seek for a description of the virtues of a good wife we may turn to Rama's lament over the loss of Sita :—

"In the management of my affairs she gave me excellent council, when I needed her services she was my servant, if I was ever angry like the patient earth she bore my impatience without a murmur, in the hour of necessity she cherished me as a mother does her child, in the moments of repose she was the source of my greatest pleasure, and in times of hilarity she was to me as a friend."

This is high praise, and could only be deserved by one who, as a good wife should do, truly shared her husband's life. The Ramayana tells us that a good wife assists her husband's religious practices with a mind devout as his own; in all circumstances she devotes herself to make him happy and shares in all his joys and sorrows; she is as faithful to him as a shadow to the body, and esteems him whether poor or rich, good or bad, handsome or deformed; in his absence or sickness she refuses self-gratification, and at his death —according to the Markundeya Puran—she dies with him.

The story of Savitri is the story of a wife who by her devotion to religion and her religious merits compelled Yama, the god of the underworld, to give her back her husband restored to life and to her affection. But the Hindoo husband is enjoined to maintain his superiority as the head of the family. In the "Brihadaranyaka-Upanishad" we read as follows :—

"She is the best of women whose garments are pure, therefore let him approach a woman whose garments are pure and whose fame is pure and address her. If she do not give in let her, as he likes, bribe her with presents. And if she then do not give in, let him, as he likes, beat her with a stick or with his hand and overcome her, saying :—'With manly strength and glory I take away thy glory,' and thus she becomes inglorious. If she give in, he says :—'With manly strength and glory, I give thee glory,' and thus they both become glorious."

It may be assumed that the marital privileges here alluded to is availed of with some freedom in other countries than India, for here in England there is the distich—

"A woman, a dog, and a walnut tree,
The more you beat them the better they be."

Perhaps the idea is common to man-nature, and the Hindoo sage has only put it the more mildly.

The Social System

But, whilst the present social system undoubtedly founded and undoubtedly follows, to some extent, the system laid down in the ceremonial laws of the Shastras, there has been as regards Hindoo women, just as there has been as regards Hindoo religion, a marked survival of the older and more ancient customs,

and in virtue of this survival, Hindoo women enjoy what they consider an ordered and secured freedom. They do not in the least desire the liberty of the West; if they did, I have no doubt they would obtain their desire, for the men would find it impossible to resist them. They now go on pilgrimages and attend bathing *ghats* just as freely as English women attend flower shows or fancy fairs. Their great work—the great duty they have taken into their hands—is the conservation and support of the faith in which they have been born. In this direction their influence is altogether remarkable, and such as to claim the utmost respect and attention. It has been well said that woman is in her nature more religious than man; nowhere is the saying more appropriate and true than in India.

And now, to show you what we speak of when we ask you to consider, or, rather, to reconsider, what you have heard of the women of India. According to the last census, there were 140,500,000 of females, against 146,500,000 of males, in the population of India; that is, the female population is nearly 49 per cent. of the total. Roughly speaking, 103,000,000 of females are Hindoos, against 23,500,000 of Mahomedans; the balance is divided amongst Sikhs, Buddhists and Jains, Christians, and aboriginal tribes. Taking 15 as the age of maturity for females, there were about 86,000,000 above, and 54,000,000 under that age. All over the country, the women of the respectable classes are *purdah-nashins*—sitters behind the curtain—whilst the women of the labouring and agricultural classes move freely and securely about. These agricultural classes account for about 82,000,000 of females, labourers for 12,500,000, and industrial occupations for nearly 24,000,000. The great bulk of these women live away from towns, and are not under the custom of the Purdah; they are occupied at home. Their chief and most prized duty is to keep the home homely, to prepare the food, to rear the children; and their subsidiary duty is to assist the men in their labours as they may be required. Their pleasures are few, and one of the most cherished is the daily gossip at the village well or village tank. As shopping is an ecstasy to the feminine mind, so these women dearly regard the weekly visit to the hat or market. They do not understand the mysteries of tatting, knitting, or sewing, because, for a large number of them, their garments are woven in a single piece, mysteriously fastened at the waist, and gracefully brought over the shoulders and head. It is easy to see that there is, therefore, little scope for needlework; but speaking from my own experience I can say that once introduced to those powerful domestic engines, needle and thread, Indian women speedily appreciate them at their highest value. The ladies of many respectable families find singular pleasure and even rivalry in their skill with their needle, or those other mysterious feminine weapons which men see and admire but are too timid to use. In many parts of India, and especially near Calcutta, Mahomedan women have achieved a reputation superior even to that of the women of Ceylon for proficiency in Chicon work, a species of embroidery with which English ladies in India are familiar, and which is not unknown or unappreciated, even in London itself.

Dress.

But I must guard you against the idea that all Indian women dress alike. Mahomedan women wear their *sari* in a way different from that affected by their Hindoo sisters. The Parsees in Bombay modify the native apparel into a particularly effective yet quiet dress. The women of the reformed religion—that is of the Brahmo-Samaj—also wear a dress which has been seen and admired here in England. All along the hotter regions of the coast the women wear the *sari*; on the Malabar coast, and in some parts of Madras, the women of certain tribes do not cover the chest. In Upper India, and especially in the north and west, petticoats are used of a kind similar to those of the Savoyard and the "buy-a-broom" women of our childhood. I suppose that in technical language these petticoats would be styled accordion pleated. One which happened to be made of stolen cloth, with a view to its being sent to the district near Agra, came under my notice; surprised at its weight, although it was made of red and black tartan, I asked how much cloth it contained, and was told 20 yards. It might have been so from the weight, although as one unacquainted with the construction of such mysteries, I felt considerable doubt as to the quantity. This petticoat was so constructed as to bunch at the foot before and behind, and seeing it one understood why the gait of the woman wearing it might be unpoetically likened to that of "A drunken elephant or a goose." But it will not do to laugh at such a garment. I remember that at the Durbar held at Agra in 1866, by Lord Lawrence, the late Rajah Ram Singh of Jaipur reduced the English ladies of the

audience to an agony by appearing in what I suppose I must call a skirt, constructed on the pattern of the stolen petticoat. In the Punjab, women wear what I suppose I must call a domino; elsewhere they make their *sari*, or sheet serve the same purpose. Where petticoats are the fashion, there is generally a jacket over which the *sari* is worn, and in many districts although corsets and stays are unknown, a very good substitute, called *angiya*, is adopted in their place.

The one remark to be made of the dress of women throughout India is that it is always decent, and that it is in a special way suited to the climate of the country. The head is nearly always covered, and the hair done up with care, except, perhaps, amongst the very poorest classes. The women take great pains in the fashion of doing up their hair. In fact, it is easy to tell Madrassi from Bengal or Hindoostani women. In the Madras Presidency, the poorer classes of women have the head uncovered to a very much larger extent than elsewhere. When a woman has the misfortune to become a widow, her head is shaved, and a more severe sign of mourning it is impossible to imagine.

All over India the women exhibit a keen aptitude for a bargain; the bulk of them have not much to spend, but they certainly get their money's worth. Few things are more astonishing than the way in which women who can neither read nor write work out by a process of mental arithmetic, all their own, difficult and puzzling problems in prices. They are in consequence much trusted by the men. They have, however, their fair share of vanity. In every province there are peculiar types of ornaments and these are much affected by the women. They are fond, too, of the fine white cotton goods of Manchester, and dearly appreciate pretty borders to their clothes. In the districts the caste of weavers still subsists, though their occupation is very materially restricted. Where weavers are resorted to it is usual to give them an annual retaining fee of a measure of grain in the husk (*paddy*); for this they are bound to make for the family paying the fee, certain garments at fixed *neriks* or rates; one *nerik* if the family supply them with thread, and another if they themselves simply take the order and furnish the cloth. With simple dyes, mineral and vegetable, they are exceedingly skilful in supplying to taste and *nerik* ornamented ends to *saris*—worn hanging down the back and borders from a simple line to an ornamentation two inches wide. It must be said for them that the clothes they turn out are exceedingly strong and lasting; many of this caste will weave exceedingly fine cloths, though the once famous industry of Dacca muslin is a thing of the past.

Ornaments.

A very interesting book might be written on the subject of female ornaments in India. As a rule, the women of the poorer classes buy silver or gold bullion in small quantities as required, or, in the case of silver, use the rupee or its silver fractions, and employ the village goldsmith to make them ornaments. When a necklace (*malla*) has to be made, the pattern is something requiring very considerable consideration and discussion. As a rule, amongst Hindoos especially, gold is not worn below the waist; it is the royal metal, which is one reason; another is that in many parts of the conntry the washermen caste (*dhobie*) claim as their perquisite all ornaments on the ankles or feet of a corpse. Looking at the assortment of jewellery in the London shop windows, an Anglo-Indian comes to the conclusion that there is a singular sameness in the displays and in the classes of articles, and that the women of the West are only at the beginning of the art of employing the aid of ornaments. A native woman of the better classes has highly worked pins for her hair; the knot at the back of the head is not unfrequently covered with a gold or silver plaque of an infinite variety of designs and beauty of workmanship. Then she may have an ornament for the forehead, also beautifully worked; in fact, while these ornaments are made of gold, the gold is of the purest, so that the ornaments always represent actual value; and, as a rule, there is a well-known rate, varying in different provinces, but varying very little, for workmanship according to style and elaboration. The *jhoomur*, or forehead ornament, is supplemented by ornaments for the ears, which may be either rings, or *puttee*—leaves—covering the whole of the ear. Then, again, where the *puttee* is not worn, there is an infinite variety of *murti*, which will be better known to English ladies as earrings; sometimes these even assume the form of a fish, and are then known as *muchchi* or *muchchli*. Where the earrings are large they are termed *kanbala*, if they are plain they are called *bali*; but the ornaments for the head are not completed without in many cases, especially with Mahomedan women, a nose-

ring. The *bulak* is an ornament depending from the nose and resting on the upper lip; it may be used with small pendants. All women wear the *nuth*, the famous nose-ring, formed of gold wire, and having on it two pearls and a ruby. The ring varies from 2 to 2½ inches in diameter. The Hindoos have, besides the jewels, two thin serrated plates of gold, set between the pearls and the ruby. The *nuth* is an indispensable accompaniment of a marriage ceremony, and once worn is seldom, if ever, put aside in the lifetime of the husband. The *nuthni*, or small *nuth*, is the nose-ring worn by children. Finally, we have the *mung-puttee*, an ornament joining the frontal ornament with that covering the hair at the back. If now we add necklaces of jewels or of gold, it must be admitted that there is verge and room enough for the widest scope of fancy on the part of the wearer, and of endless resources of ingenuity and skill on the part of the jeweller. Noble and wealthy families have goldsmiths and jewellers as integral parts of their establishments. In England, the custom has been adopted from India of wearing what are known here as *choories*. In India the *choorie* is made of coloured glass or lac, and is worn by the women of both sections of the community. The *choor*, which is made from conch shell, is only worn by Hindoo women. The silver rings worn in England are really called *butana*, and in India are either four or six in number on each wrist. The necklet is called *hunsli* or *touk*, it may be of gold or silver, but is usually shaped like the letter "C." If made of pearls or precious stones there is often a centre pendant, shaped more or less like a half-moon, and called a *joogni*. Then there are charms called *dook-dooki* made of jewelled jade and supposed to be effective in bringing ease to a fluttering or aching heart. On the arms, besides the *butana*, the *choor*, or the *choorie*, there are the *bazubund* or *bhooz-bund*; these are armlets worn above the elbow and may contain charms. The poorer women in different provinces, especially in the east and south, wear on their arms a tremendous quantity of brass or white bronze ornaments weighing sometimes as much as from 5 to 12 lbs. The fingers have rings; among the poorer classes these are set with glass, cornelian, agate, and even garnet, and vary from a plain circle to an elaborate seal an inch in its largest diameter. The better classes have a variety of necklaces, the poorer have their *chumpa-mali*, their *muchchli-mali*, or their *mircha-mali* flower, fish or *chili* pattern necklace. Silver anklets in the case of the poor, give place to brass or white bronze—*goorbala*, these are often of considerable weight, and it is no unusual thing to see a woman of the inferior castes shortly after marriage walking with her anklet carefully raised, or suspended by a cloth because of the way in which it has galled her heel or her ankle. I have only been able to give a brief and rough outline of a very large and important subject requiring almost, with its variety of names, a literature to itself. Those who wish to see for themselves some good varieties of Indian female ornaments should spend an afternoon in the Indian Section of the Imperial Institute.

Daily Occupations.

I may supplement what I have said by dwelling for a short time upon Hindoo home-life and the occupations of women in a Hindoo home. I have said that marriage is a very serious matter with the Hindoo; its object includes not only peace and comfort in this world but salvation hereafter by the performance of acts of piety and benevolence in which a wife must of necessity take part. Then again through the wife the husband obtains children and thereby secures the perpetuation of the family oblations to his ancestors. Whilst the husband, as I have shown, is the lord, the wife is regarded as the sinister half of his body and as an emblem of peace and plenty, having a significance extending beyond this life. By marriage the Hindoo becomes *grihastasram*, that is a man with a house and a home, a domiciled member of society, an honourable and honoured degree in life. A man's life in fact is incomplete until he has secured for himself the support, assistance, comfort, and religious benefit of a wife. Should he die the wife becomes *bidhaba*, this is the root of our word widow, it means "a woman without a lord." Nothing redounds so much to the credit of Hindoo women as the way in which they bind up their interests with those of their husband's family, and the manner in which they set before themselves the good order, welfare, and comfort of the household. In the majority of cases—and I am speaking of a respectable family—it is "joint," and consists of father, brothers, uncles, cousins, and other relatives, with wives, sisters, and dependents. The eldest member of such a family is called the *kirta*, and he is the active chief and occupies a position giving him the patriarchial right to claim the obedience and co-operation of all the rest. The younger

members are taught from their infancy to respect their elders, and to submit to their councils and their actions. It is always a serious matter when such a family becomes disrupted; the partition which then ensues is sure to waste a great deal of the substance of the family in litigation. To make what follows understood you must bear in mind that a Hindoo house consists of at least two residences, one behind and attached to the other. The larger houses have several interior sets of apartments, each set has its own courtyard and generally its own well; the outer set is the common meeting place of the male members of the family and is used for the reception of male guests. It has attached to it a "dallan," or hall of worship, where an idol is kept, and where public religious ceremonies are performed. All houses have verandahs outside and inside which serve as passages to the various sets of rooms. The family idol is kept in a special room generally at the top of the house. It is jealously guarded, and not unfrequently has its own special endowments, of which the head of the family is the *sevait* or administrator. The house has all necessary accommodations and as a rule has three cook-rooms or kitchens. One of these is used exclusively for the preparation of the food offerings required for the use of the family idol. In this cook-room rice is not allowed to be boiled. A second kitchen is reserved for the use of the widowed members of the family; in this no fish or unclean thing can be prepared. The third is the general cooking-room of the house. In not a few houses the cooking is done in this room by a Brahman cook, male or female, while the ladies of the family have a fourth cooking place where they and they only prepare food. There is a great love of plants and flowers—the terraces afford abundant proof of this statement. In all houses there is to be found the *tulsi*, the sacred plant connected with the worship of the family idol.

This being the home, we have now to turn to the ladies who inhabit it, and to go through a day with them. As soon as a woman awakes she recites certain prayers; reverently salutes the pictures or sacred images in the room, and then kisses, in honour of Lukhi, the gold bangle on her wrist or the golden amulet on her arm, and having done all this, is ready to leave her bed. Next, they anoint the body with oil specially prepared for the purpose, and oftentimes delicately scented. The hair next receives attention; it is dressed and treated with oil, but among respectable people this oil is also prepared in the house by the women themselves, and by methods which they keep to themselves. The hair having been finished, the lady is ready for her bath, prior to which she uses *manjam*, a dentifrice not unfrequently prepared from betel nut and finely aromatic; the *manjam*, like the oil for the hair, must be prepared at home; the ingredients and scents used are never taken at hap-hazard, but are such as have a well-earned reputation for, as the case may be, preserving the hair or the teeth in a healthy and attractive condition. The ceremonies of the bath, or perhaps I sbould more rightly say, the mysteries of the bath, having been concluded, the ladies, according to the season, attired themselves in silken or woollen cloth; they then sprinkle Ganges water, or water made holy by an admixture of Ganges water, on their heads, and next sprinkle the same water on their beds. This part of the day's duty concludes by an obeisance to the sun. When all these duties and observances have been got through, a visit is paid to the cook-room and the household-room, where certain prayers are recited, and then there are the children and any sick members of the family to be attended to. The store-room is opened, and the kitchen utensils and other needed articles issued so that they may be washed and cleaned and made ready for use; and, of course, thought, care, and conversation is given to the dishes which will have to be got ready for the family, for the sick, and for the little ones. Having thus disposed of necessary employments, a lady's next care is to see that articles required from the bazaar are sent for. These are usually vegetables, fish, &c. The store-room is examined with a view to ascertain that it contains a due and proper stock of rice, pulses, oil of sorts, *ghee* (clarified butter), sugar, sugar-candy, spices, fuel, and so on. It is usual to maintain a stock of these things calculated for a month's consumption. Then the milk and fruit have to be continually looked to, and the progress made in the cooking has to be overlooked and attended to; betel nut and pan leaves have to be prepared so as to be ready to be served immediately after the morning meal, and a good housewife will not unfrequently prepare with her own hands some special favourite dish for her husband. It must be kept in mind that the women do not eat with the men; a good housewife will, however, attend her husband's meals, to see that he is well served, and that he does justice to his food. This mark of solicitude is highly

appreciated. After the morning meal, the male members of the family proceed to their ordinary avocations, but not until they have changed their clothes and completed the morning worship. The women are at liberty to also finish their religious duties; to take their own meals; to see that the servants are at liberty to take their food; and not unfrequently they distribute food to beggars, and other persons in distress, who may be in waiting. After the morning meal, the women are at liberty to occupy themselves as fancy or liking may dictate: many of the elder ones read the "Mahabharata" or "Ramayana," the two great sacred epics, or the "Bhagavad Gita," or sacred song, that poem where Khrisna reveals to Arjuna the deeper mysteries of the Hindoo faith. The younger women—especially of late years—resort to wool-work, knitting, sewing, or writing. Just as in ancient times Hindoo women were renowned for their intelligence, so now-a-days they produce poets and writers, whose work is of high merit, but is, as a rule, hidden from Europeans in the veil of the vernacular. There is also setting in a fashion of spending some time at the piano or harmonium. It is curious, however, to note that the older generation complain that the girls deteriorate as housewives and as cooks in proportion as they show proficiency in these new occupations. But the day has to be got through, and hours in idleness are long. Crewel work, and even music, are not sufficient to distract women from the obligations of making their beauty as pleasant and attractive as they can in the eyes of those to whom they are bound by affection; and I do not hesitate to say that more affectionate wives than the Hindoo women do not and cannot exist. Naturally, therefore, the toilet receives a considerable share of attention; cosmetics have to be prepared for future use, and have to be applied. The hair is attended to with extreme care, one lady assisting another; the vermilion mark of wifehood has to be made upon the forehead; and, on special days, female barbers attend, and pare the nails of the hands and feet. These attendants also colour the feet with the juice of henna leaves, or use for the same purpose cotton soaked in a preparation of lac dye; then comes the great bath of the day, but taken in such a way as not to wet or disturb the hair. After the bath, clothing is inspected, and the special dress to be worn duly selected, light refreshment is taken, and home amusements indulged in until nightfall, when the conch has to be blown, and holy water sprinkled in all the rooms. Incense is placed in a special burner, and with it every room in the house is fumigated; the lamps are lit in the rooms that are in use; whilst in all the others a lamp is taken in, and, as it were, the light is shown to the room, which is then closed. Finally, the evening worship of the family idol is performed, at the conclusion of which the Purohit, or officiating priest, gives each one to drink of holy water; he pours it into the hands, which are carried to the mouth for the purpose. It is significant that their hands are always dried on their heads. The elder ladies recite prayers, and tell their beads, naming certain deities, the others attend to the preparation of the evening meal. When the men have eaten, the ladies attend to their own food, to the infants, the sick, and the servants. After the evening meal there is the final change of dress for the day, and a breaking-up of the family into groups, according to the pleasures to be enjoyed or the duties to be performed. If the younger recite poems or tales, the elders resort, as in the morning, to the religious legends to be found in the sacred books. When the time for rest has arrived, each is careful to recite her prayers and to make obeisance to the divinity.

Miscellaneous.

There are many holy days in the course of the year, and when these occur the women rise exceedingly early, and if a river is within reasonable distance of their place of abode, they will proceed to its banks at such a time as to enable them to bathe and return home before daybreak. Should a fast fall to be observed, they keep up at night amusing themselves by playing at different games of cards, or they listen to religious doctrines recited by the elder women or by professional female mendicants engaged for that purpose.

They are not without social festivities or friendly society; they pay and return visits, and have parties generally of a number from ten upwards. The invitations from relatives are attended to by the women; these feminine parties are held in the women's own apartments, and the male members of the family are scrupulously excluded from such festivities. When these parties are given, professional women are engaged to give nautch dances, or to sing.

It is almost needless to say that for the performance of the duties I have sketched out, a careful training is requisite; girls are, there-

fore, from their earliest years, brought up to consider and love the duties they will have to perform after marriage. By precept instruction, example and discipline, they are taught a high ideal of womanhood; modesty, chastity, benevolence, worship, tolerance, domestic management and economy are inculcated, and a girl is trained to regard herself as a means of imparting peace, harmony, comfort, and pleasure to her surroundings when she leaves her father's home for that of her husband, and to conduct herself so as in her turn to exercise fully the duties of the senior lady of the house. Now-a-days girls are taught to read, write, and keep accounts, and are also encouraged to acquire certain Western accomplishments.

I have said that even *purdah nashins*—women who ordinarily live behind the *purdah*—attend pilgrimages. I have also shown that they have their own special gatherings at home and at their female relatives' or friends' houses. They thus see a good deal of the outer world, but, so far as I have been able to ascertain, they are averse to mix with that world, and they do not desire to change their mode of life, their habits, or their customs, for what we naturally suppose the superior status of women in the West. In fact, the new woman will not find disciples or imitators amongst her sisters in India.

Now, I should be giving a false impression if I did not bear testimony to the happy side of Hindoo married life. The women, by their training, are strongly practical; they are, as a rule, capital managers and extraordinary cooks. In this direction the women of the Banker class and the Brahmanis dispute the palm. The men, it may be said, earn wealth, the women keep it. A woman is reminded of her duty to the prosperity of the house every morning when she kisses her bracelet, and four times in the year when the senior lady presents a little store of rare coins, or coins offered to the divinity with appropriate ceremonies, before the goddess Lukhi. Is it therefore to be wondered at that the senior lady of every family of note exercises an influence binding the families together, and keeping it faithful to its traditions and national faith in a way which is as a crown of glory to the womanhood of India. They prove admirable administrators, they pacify disputes, they reform the erring, they encourage and strengthen the young. Their displeasure is always a thing to be dreaded and, if once seriously engaged in a dispute, womanlike they go through with it to the end.

But, while I assert that there is a number of bright sides to the Hindoo domestic life, and whilst I deny that Hindoo women have a necessarily miserable life, I admit that there is an urgent need for such an institution as that noble fund founded by the Countess of Dufferin with the sanction, if not at the personal suggestion, of the Queen. It may seem strange to English people, but yet it is undoubtedly true that the Queen—Empress of India—is a personal Queen, a personal and beloved sovereign to the women of India. She is to them a fountain of beneficence, a model wife, a pious and faithful widow; her virtues are in their eyes those of a perfect Hindoo woman, and nowhere in all her wide Empire is she so appreciated, so loved, and so regarded as in India. This is her best tribute from the women of India, and their highest praise.

After the reading of the paper, Sir ALEXANDER WILSON added:—

And now, ladies and gentlemen, having read to you Mr. Clarke's paper and, as I hope awakened in you a new interest in the women of India, I would like to add a few words of my own upon the Countess of Dufferin's Fund to which he makes reference in his concluding words.

To many of you, perhaps, the very existence of such a scheme to ameliorate the condition of your sister subjects in India may be unknown, but you will all have gathered from Mr. Clarke's brief sketch of the social life of the women of India that medical aid, in the sense that the Western people regard it, could not be availed of by them; indeed, most Indian women would rather die than see medical men. You can easily, then, picture the miseries which your fellow-subjects in India have had to undergo in the past.

The idea of amending this state of things emanated, as Mr. Clarke states, from her most gracious Majesty the Queen-Empress, but it was a most happy circumstance which led to the entrustment of the development of the scheme to the then Countess of Dufferin when she went to take leave of her Majesty prior to her departure for India in 1884.

I am privileged to know with what assiduity Lady Dufferin devoted herself to the noble task which had been confided to her, and, to understand the importance of the movement, you must realise that not only by their religion and custom were the women of India debarred from the aid and professional assistance of medical

science, but that there was no existing means by which such science could be brought to their knowledge and relief.

It reflects, therefore, no small credit upon Lady Dufferin that, within eight months of her arrival in India the prospectus of a scheme on strictly unsectarian principles was issued by her from Simla, which embraced on broad and comprehensive lines what is now, and will be for ever, known as the "National Association for Supplying Female Medical Aid to the Women of India."

I will not weary you by entering into all the details which the development of such a gigantic work involved; but I will, in as few words as possible, tell you the objects of the Association, and the results which have attended its operation. The objects are twofold:—

1. Medical tuition, including the teaching and training in India of women as doctors, hospital assistants, nurses, and midwives.

2. Medical relief, including the establishment under female superintendence of dispensaries and cottage hospitals for the treatment of women and children. The opening of female wards under female superintendence in existing hospitals and dispensaries. The provision of female medical officers and attendants for existing female wards. The founding of hospitals for women where special funds or endowments are forthcoming. The supply of trained female nurses and midwives for women and children in hospitals and private houses.

For the furtherance of these objects it was necessary to obtain the services of properly qualified lady doctors from this country, and to raise funds, and to the appeal for subscriptions to the Countess of Dufferin's Fund the princes and people of India responded generously.

A Central Committee was established under the presidentship of Lady Dufferin, which was entrusted with the general management of the Association.

Branch associations were formed throughout India, with local committees, and the hearty co-operation of all interested in the well-being of the people of India was invited.

I should like to take you, step by step, through the development of this great work, if only to show you what I and those who with me were privileged in being associated with Lady Dufferin in the work, so thoroughly recognise, viz., that the success which has been achieved is largely due to the personal efforts of the founder, Lady Dufferin, and the succeeding lady presidents, Lady Lansdowne, and now Lady Elgin, but time does not permit. Suffice it to say that the scheme initiated at the end of 1885 has in eight years developed the length and breadth of that vast empire of India. Its operations extend from Quetta to Debrooghur on the extremes of the northern frontier to Tinnevelly in the south.

No less than 65 hospitals and dispensaries, directly under, affiliated to, or in connection with the Association, existed at the end of 1893, of which ten were constructed by, and are entirely supported by native chiefs and princes, and on these 65 a sum of over seventeen lacs of rupees have been expended on buildings.

At the same date (for we have not yet received the figures for 1894) there were 13 lady doctors, 42 assistant-surgeons, 45 hospital assistants (the latter 87 having been trained by the Association), were employed; 601,574 patients were treated in 1893, of whom 13,058 were "indoor" patients; and there were 224 female students then attending various colleges and schools in training for the work.

In addition to the seventeen lacs of rupees, which I have already told you has been expended on buildings in connection with the Association, the invested fund of the central and provincial branches amounted to nearly twenty lacs more, so that in less than nine years the Dufferin Fund has become possessed of property to the value of thirty-seven lacs of rupees, and it is, therefore, assured of a permanent and prominent place among the national institutions of India.

A branch has been formed in this country with the object of (1) bringing the aims of the National Association prominently before the British public; (2) to aid in raising subscriptions for the "Countess of Dufferin's Fund;" (3) to select and pay passage out of such lady doctors as may be required for the Association in India; and (4) to aid, by grants of money, medical students coming from India to study in England.

Lady Dufferin and Ava has, with unflagging interest, herself undertaken the duties of secretary to the United Kingdom branch, and if I have been fortunate enough to-night to awaken in you a deeper interest in the women of India, may I point out to you that you can assist in ameliorating their lot by sending subscriptions or donations to Lady Dufferin and Ava at the British Embassy, Paris, or to her secretary, Miss Heather Bigg, 14, Radnor-place, Hyde-park.

Only yesterday I received a letter from Lady Dufferin, telling me that already the services of trained Indian women were preferred to those of English ladies, so that there will be increased claims on our home funds to help those Indian ladies who come to complete their studies here.

In conclusion, I would only quote the words of Rudyard Kipling on Lady Dufferin's work:—

> " If she have sent her servants in our pain,
> If she have fought with death and dulled her sword,
> If she have given back our sick again,
> And to the breast the weakling lips restored,
> Is i a little thing that she has wrought?
> Then life and death and motherhood be nought."

DISCUSSION.

Mr. S. Digby, Secretary of the Section, read the following letter, which had been received from Miss Billington, the authoress of " Woman in India."—

" Had I not been absent on a short and much-needed holiday in Dorsetshire, I should certainly have been present this afternoon to hear the very interesting paper written by Mr. S. E. J. Clarke, of Calcutta, which Sir Alexander Wilson has just read. Thanks, however, to the courtesy of Mr. Digby, I have been favoured with an advance copy, and am, therefore, able to express my cemplete concurrence with its general purport and tenour. The mistake which it invariably seems to me is initially made in approaching the subject of the condition of Indian women is to adopt a tone of patronage towards them, forgetting always that they possessed a civilisation already old when our own began, while there is a tendency to look for the mistakes and shortcomings of the system, rather than to seek the recommendations and advantages which it must undoubtedly own when we bear in mind that it has survived along centuries of revolution, change, and conquest. My own inquiries showed me that in the majority of cases where European education has been accepted, it is seldom accompanied by any desire to set aside old social habits. The women are satisfied with their lot, and do not feel themselves either degraded or humiliated by their environment. Their ideals of pleasure, of love, of amusement, start from such different standpoints from our own that it is, no doubt, difficult for the European women to see them as they do, and yet, it is only by womanly, intuitive sympathy, paradoxical as it seems to say so, that one may hope to enter into their hopes and aspirations. Their religion suffices for happiness as well as duty; the care of the children, and the domestic well-being fill the regular day's routine, with them no less than with our own women. Nothing perhaps shows mcre conclusively that the spirit cf unrest and dissatisfaction has not fallen upon them than the phenomenally small ratio borne by female to male crime. Mr. Clarke's comments on the dress and jewellery of the women show close and accurate observation, for though the broad outlines of the graceful dress, of which the *sari* is the garment characteristic of Eastern womanhood are the same, there are minor diversities peculiar to almost every district. The most curiously scanty attire that I saw was that of the Nair women, on the Malabar Coast about Calicut and Tellichery, where only a loose petticoat of white reaching from waist to knee is worn, as, by a curious perversion of the views which generally obtain, it is indicative of immodesty of life and low caste to cover either shoulders or bust. I can fully endorse his remarks as to the curious process of mental arithmetic by which they work out puzzling sums, as I do not think anything astonished me more than the way that a class of little Kol and Santali girls, in the mining district of Girideh, answered, for me "pat" such sums as $17\frac{1}{2}$ times $19\frac{3}{4}$—problems which I had to test with paper and pencil! I regret very much the deterioration in needlework and embroidery, which has been introduced by our Western methods and designs. This one observes with sorrow from Madras to Delhi, from Calcutta to Calicut. In the missionary schools, girls have been taught the worst back-parlour horrors of Berlin woolwork, crewel work, and the making of atrocious green and magenta, or red and violet, mats; and a taste for these and similar monstrosities has spread like a bad plague through the zenanas. Even from an utilitarian point of view, this is to be deplored, as there can be no possible market for such tasteless productions, though Europe would buy good and beautiful indigenous work to almost any extent. Education, however, will only modify the existing conditions of life among the women very, very gradually. More rapidly, however making for good as a factor in the situation, will be the Dufferin Fund, bringing comfort to the body, and indirectly paving the way for further influences from the West. In the abstract, all are ready to commend the noble scheme—surely the greatest and most truly lovable ever devised by woman's brain, but not until one has seen it in actual working, not until one has grasped its whole-souled purpose for meeting the very greatest of the needs of Indian women, does one realise how vastly it is making for righteousness among them.

Sir Steuart Colvin Bayley, K.C.S.I., said this was a most valuable paper, not merely because it gave many interesting details about the daily domestic life of the women of India, but especially because it threw a good deal of light on a subject on which a great deal of misapprehension existed, and gave a much more correct view than that generally held in England on the subject of the domestic relations of women in India. It was especially valuable as pointing out the very strong influence which women as the rulers of the household exercised in the direction of shaping both the religious and moral tone of their male relatives. The two things

were not identical, and did not quite occupy the same plane—perhaps less so in India than in the West, but in both cases women had exercised a real and very beneficial influence. He thought, too, that the general notion with which the audience would go away as to the happiness of domestic life in India would be a tolerably correct one, but it would be an error to suppose that the view commonly held in England was absolutely without foundation in fact. The writer had drawn a fairly accurate description of the average domestic life in a respectable family; of course, in families of a lower social scale there would be less refinement and more roughness, as in England; but quite apart from this, the divergences of race, of origin, of tribes, and castes were innumerable, and you could scarcely predicate with any approach to accuracy, because you knew what went on in Calcutta, the status of women in other parts of India. For instance, you found amongst the Khasias in Assam, that the woman was not only ruler of the household, but the ruler of the family; the children were her children, and the husband had no control over them. The husband was a visitor in her house. If he had any money to leave, he left it, not to his children, but to his sister's children. The inheritance both of the chiefship and of property went from a man through the sister to the sister's son. A woman left her property to her own son. It might be said generally that amongst the semi-Hindooised and the aboriginal tribes, the life of women ordinarily was almost as unrestricted as in the West. The higher you went in the social scale the more restrictions were found, although there might be an exception at the very top where royalty was able to make its own etiquette to a certain degree. No doubt the happier and brighter view put forward by Mr. Clarke was, on the whole, accurate; but of course those who had been brought into contact with crime in India knew that there was another and a darker side to the social system, with which he had no desire to deal, and it would be no more a fair representation than it would be to take the annals of wife-beating in Whitechapel or of the divorce-court as a fair specimen of English life. Where there was brutality or cruelty, it was pretty sure to find its outlet in those directions where there was likely to be least resistance, and the extent of it would, to a great extent, be measured by the checks which it would meet with from public opinion, and the chances of impunity; and it was obvious that the social seclusion of India did afford less protection than the more open customs of the West. Whether it would be wise to give up the seclusion for the sake of the protection was another matter; he did not think it would, but he did not think this side of the question ought wholly to be ignored. It would be a mistake to suppose that because the women of India had no desire, and rightly so, to imitate the social customs of the West, that, therefore, no improvement in their condition was possible. The fact of the enormous disproportion between the number of boys and girls under instruction in India was a very significant feature. No one could look forward and say that in the long run it was safe that the men should be open to all the influences of Western reading, and that the women should have all that book closed to them; nor did he think that the men themselves would for long wish to have it so. Then came the very serious difficulty of how instruction was to be imparted. The most successful way he believed would be by instruction being given by native women, and if he might follow the example of Sir Alexander Wilson in speaking of the Dufferin Fund, he would say that just as the work of Lady Dufferin tended to ameliorate the physical condition of women in India, so, on a smaller scale, and in much humbler circumstances, the work of the National Indian Association in aid of Social Progress and Education in India, under the guidance of Miss Manning, tended to improve their mental condition. The line which the Association had taken was to instruct women, and especially widows, and to train them as teachers, both in domestic life and in schools. He thought that was almost the only way in which education could be so gradually and quietly introduced as not to cause any serious commotion, so that, in fact, it should be received, as an evolutionist would say, in harmony with the environment of their life. He thought this would prove to be the line of least resistance, and from that point of view he ventured to recommend the work of Miss Manning and the National Indian Association.

Mr. M. M. Bhownaggree. C.I.E., said he thoroughly agreed with what had been said as to the excellence of this paper. It was a full and picturesque description of the life of the women of the households of rich independent families, and was peculiarly a description of the women in that state of life in Bengal. At the same time, with a little variation, it applied equally to the modes of life of the women of respectable families in other parts of India as well. He must also express the great gratification with which he heard Sir Alexander Wilson bring forward so eloquently the noble work being performed by the Lady Dufferin Fund, and he hoped the advocacy of the cause would interest all those present in the progress and prosperity of the work, and induce them to give it not only their attention but material assistance. But throughout the reading of the paper there appeared before him a strange vision of future danger, and he was pleased to say that in the eloquent speech of Sir Steuart Bayley it had been, to a certain extent, modified. The danger of sending such a paper to India without the proper lessons being drawn from it, was that those who were apt to look on the condition of women in India as perfect or blissful, would take this as an expression of what their influential and educated friends in England were saying, that the native women led happy and intelligent lives, and that there was no necessity for them to be educated. Now that in the

present state of the Indian mind with regard to female education would be a positive danger, and he, for one, would venture to add a moral to the paper, that, whereas it was a beautiful picturesque description of the family life of the women in India, it fell short in not drawing any lessons as to the future duty of men in India towards them, and also of those English friends who were expected to guide them with regard to the education and further enlightenment of the women of India. The writer of the paper said it was a mistake to suppose that the women of India regarded their life as a miserable one, and he quite granted that, but what was the reason? Because their standard of the privileges and enjoyment of life was low; no one could deny it. It might be said that if the women were willing to consider themselves so happy, nothing more was required. But Ashanti women or Zulu women did the same. He did not demur to leaving the women in their present condition if the men were to be left in that condition too; it was an extremely patriarchal condition. There were no underground railways, no telegraphic messages, no rushing to public meetings, or anything of that sort, and if the men of India were not adopting the modes of Western civilisation, by all means leave the women in their present blissful condition of primitive life. But so long as the mission of the British Government seemed to be to educate the future generation of the men of India, it was not only a failure of duty, but positively culpable to remain quiescent, and do as little as was being done for the education of the women. The great danger of such inaction lay in this fact, the men were being educated—in his opinion, over-educated—in comparison with the resources of the Indian exchequer, and in proportion to the necessity of providing for the elementary instruction of the masses he considered the contribution to higher education in India was certainly out of all proportion to what it was in the civilised countries of the West. That being so, a large class of men was being created which was becoming, in one sense, a sort of danger to the empire, the existence of which was not calculated to strengthen the foundation of British rule; at the same time, the women were not educated in a manner by which those higher qualities, which they certainly possessed, for the development of the religious and moral sense could be brought to bear on that education which was being given to certain sections of the people of India at present. He thought these lessons, which really arose out of this excellent and admirable paper, should have been drawn at its conclusion and he had felt it his duty to refer to them, lest an incorrect impression should be conveyed regarding the desirability of improving the condition of the women of India.

Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., said at that late hour he would do no more than express his cordial concurrence in the views expressed by Mr. Clarke, and his complete disagreement with those to which Mr. Bhownaggree had given utterance, leaving any necessary amplification of his remarks for the report in the Society's *Journal*. He had listened to the reading of Mr. Clarke's picturesque and eloquent account of the present condition of the women of India with the liveliest interest and gratification. Mr. Clarke entirely confirmed the opinions of Miss Billington on the subject, as given in her admirable book, recently published, on "Woman in India," one of the most informing books ever written on India, and inspired by the spirit of true statesmanship. The reason of the present generation of English people being so much more ignorant of India than their fathers and grandfathers was that, the circumscribed society of the times in which the latter lived was widely educated and highly cultivated, whereas the society of our days, has, through the discoveries of gold, and the adoption of free trade, become enlarged by overwhelming masses of self-made men with no traditionary culture and little knowledge beyond that acquired by their own experiences of life, and is, therefore, necessarily as ignorant and prejudiced as it is healthy and energetic. We owe our present unique industrial and mercantile position in the world to these new men; but they are essentially barbarians, and during the transitional period through which we are now passing, their prejudices and ignorances are a source of incessant inconveniences and embarrassments, if not of actual danger to the empire. Mr. Clarke's paper, which, he hoped, might be reproduced in permanent form, and Miss Billington's book, are calculated to remove much of this ignorance and prejudice, at least, as regards the women of India. He thoroughly appreciated Miss Billington's sentiment that the air of superiority with which we were apt to discuss questions like the present savoured too much of our insufferable insular self-conceit. It was an axiom that races and nationalities should be judged by their ideals of themselves; and as the women of India — India of the Hindus—were essentially of the same race as the women of Europe, so the Hindu ideal of woman, as described in the "Ramayana" and "Mahabharata," and the later national dramas, such as "Sakontala," was the ideal also of Homer, and Sophocles, of St. Paul, the Hellenised Hebrew, and of Shakespeare, in a word, the universal Ayran ideal. Mr. Clarke was quick to point out the different ideal of the Hindu woman which the "Code of Manu" seemed to indicate; but it was only seeming; for the "Code of Manu" is a law book, and a rule, not only of national and communal life, but of intimate social and domestic life, In the latter respect it is a sort of combination of the "Book of Leviticus" with Buchan's "Domestic Medicine." But the true, refining, and elevating sentiment of the Hindus in regard to their women is sufficiently seen in the texts of the "Code of Manu," which declare that the lips of a woman are

always pure; that the names of women should be soft and musical, and express a benediction; and that a wife, who is a mother, is a real goddess of nature. When Homer tells us that Helen was worth all the ten years' war the Greeks and Trojans waged for her possession, for that she was "an awfully fine woman, *like to the deathless goddesses*," he is giving expression, at the best, to but a noble and heart-stirring compliment. But the text of the "Code of Manu," to which he had referred, expresses the widest and deepest conviction of the Hindu mind of the absolute divinity of motherhood. Mr. Krishna Menon, who would shortly read a paper before this Society on "The Village Communities of Southern India," some time ago read a paper before the Madras Hindu Social Reform Association on the "Hindu Ideal of Woman," in which he quotes the following text from Vasishthá, a great moralist:—"The teacher is to be reverenced ten times more than the tutor, the father a hundred times more than the teacher, and *the mother one thousand times more than the father*." The fact is that the whole idea of the divinity of motherhood comes to us from the East and particularly from India. Much of the hagiology, and nearly all the mediæval iconography of ecclesiastical Christianity, are in their historical origins, Buddhistic Hindu. In that beautiful early seventeenth century English hymn beginning—

"Hierusalem, my happy home,"

the verse omitted from Protestant versions of it—

"Our Lady sings *Magnificat*,
With tones surpassing sweet,
And all the virgins bear their part,
Sitting about her feet"—

presents an enchanting picture, which is in motive and composition characteristically Hindu. That the women of India realise their highest ideals has been sufficiently shewn by Mr. Clarke. He (Sir George Birdwood) could give similar testimony from his personal history, but preferred to corroborate Mr. Clarke from a French writer who, some years ago, published a book on the women of the whole civilised world. In this book, he gave the palm for physical beauty, and moral elevation, not to the women of France, but of England; and he placed, as only second to them, again, not the women of France, but the women of India! And he was right, for there is in the Hindu woman the same strong sense of duty as in the English woman; the same intuitive purity and natural innocency of soul; the same constitutional gentleness and refinement of manner; and the same latent reserve, and even primness of demeanour which is, in at least the eyes of Englishmen, the crowning charm in the portraiture of a true English woman. The future of India, and the future of England in India, are safe in the keeping of such mothers, and wives, and daughters; and nothing had heartened him more than the emphatic testimony borne by Mr. Clarke to the intense religious feeling of the women of India, and to the great position they have in consequence achieved as the zealous and unyielding guardians of the social, industrial, literary, artistic, and other national traditions of their ancient country; in other words, as the guardians of the continuity of Hindu culture, and of the unique historical personality of the race of Brahmanical Hindus. To destroy the personality of a race, and the continuity of its culture, is the most appalling crime that can be committed against humanity; and it is to their highest glory that the women of India will not willingly be participators in any such treason against the ashes of their fathers and the altars of their gods.

The CHAIRMAN said that the Secretary had been informed by the Duke of Connaught that had His Royal Highness been disengaged it would have given him the greatest pleasure to have presided at a lecture "on a subject in which His Royal Highness takes great interest." Engagements elsewhere had prevented the attendance of Lord Northbrook, Lord Lansdowne, Lord Reay, Lord Roberts, Lord Sandhurst, and others, who took a similar interest in Indian questions, and more especially that of the position of the women of India, one of the most important problems of the day. He did not intend to offer many remarks of his own beyond proposing a cordial vote of thanks to Mr. Clarke for his valuable paper, and to Sir Alexander Wilson for so kindly reading it. He was very glad that Mr. Clarke had been able to clear up some misconceptions of importance as to native family life in India; and if his testimony were of any value he desired to say that after some years' residence in that country his own experience went far to corroborate all Mr. Clarke had said on the subject, and that a close and valued friendship with some of the leading Indian families there induced him to think that in many respects their home-life was much more civilised than was generally believed, and afforded an example, in some respects, which we in the West need not be ashamed to follow. He alluded more particularly to the religious life in which the women of India took a leading part, the desire that actuated both men and women of the family to do well, the close tie that existed, more especially among Hindus, between members of the same community, and the wish to be kind one to the other so far as their customs, rules, and habits permitted. It was no doubt true, for it had been stated on good authority (that of the Rev. H. Rice, of Madras, whose book on "Native Life in North India" everyone should read), that many Indian women lead an aimless life, that they lounged about from room to room, and that they spend a good deal of time in putting up their hair and taking it down again, and in putting on jewels and taking them off again; it was also true that the only healthy excitement obtainable

in many households was a good quarrel, which came in handy occasionally to relieve the monotony of their existence; that again, in many instances, the supreme administrators of the family were the mothers-in-law, who ruled their subjects with a rod of iron, or else the grandmothers, who arranged everything according to their own sweet will. But was not all this equally true of our own Western womenkind, and of our own family life? As to the future of the women of India, it could not be denied that Hindu widowhood, as it existed, infant betrothal and marriage, and a certain amount of unnecessary seclusion, were rugged obstacles in the path of woman's life and progress in the East; but still a great change had come over the better spirit of India within the last few years, and it might be hoped that by patience, forbearance, the recognition of the good that existed, and the spread of education and Western enlightenment, the women of India might again fill the distinguished position which they occupied in the vedic age, and in the periods of the "Ramayana" and "Mahabharata." He felt that they could not too highly appreciate the beneficent scheme initiated by Lady Dufferin, supported by the Queen, and carried on by many eminent men and women of the day; a scheme which had gained the hearty support of the leading princes, and other fellow subjects of India, and which was one of the greatest blessings that had been brought to the doors of Indian family life for many a long day. This scheme had succeeded beyond the most sanguine expectations of its promoters; it was worthy of the support of all who were interested in our great dependency of the East; and, as said by Sir William Hunter, "It was one of the most magnificent enterprises of benevolence ever projected by a woman's brain."

APPLIED ART SECTION.

Tuesday, February 5, 1895, LEWIS FOREMAN DAY in the chair.

The paper read was—

DRAWING FOR PROCESS REPRODUCTION.

By GLEESON WHITE.

The title of to-night's paper irresistibly reminds me of the Knight's song in "Alice in Wonderland," which, as no doubt you remember, was called "Haddock's Eyes;" but that was only "what the name was called;" its real title was "A-sitting on a gate." In the song itself there is nothing whatever about gates or even about sitting. Now the name of this paper may be *called* "Drawing for Process Reproduction," but what its title should really be is quite another matter; perhaps, later on, a more reasonable description may suggest itself.

One of the most painful moments in the life of an expert is surely when he is introduced to a stranger, who immediately proceeds to instruct him in the mysteries of his own craft. It is like being re-told a good story by the man to whom you told it. Politeness demands silence and apparent attention, but after a time the restraint becomes intolerable. As the elementary details are being more or less inaccurately told you, or the story is deprived of its point—you feel that the strained situation might supply a question of manners for a competition in a society paper.

Starting with idea of bringing together practical hints in the preparation of drawings for process reproduction, I soon saw that to do so would put me in the position of the superfluously garrulous outsider, if I attempted to expound first principles to masters of both crafts—that of drawing for reproduction, and the reproduction of drawings—which are implied by the title of the subject for this evening.

The records of the Society of Arts are full of most instructive papers on Illustration in all its bearings. In the past, Mr. Comyns Carr, Mr. Carmichael Thomas, Mr. W. J. Linton, and Mr. Walter Crane, to name a few, all admirably equipped for their efforts, have delivered most excellent lectures. Only lately we had the pleasure of hearing Mr. Horace Townsend discourse on a branch of this subject, and, still later, Mr. Henry Blackburn in a series of Cantor lectures covered the whole ground, or as much of it as any man could hope to do in a given time. Therefore, feeling it would be folly to attempt to traverse the field so thoroughly worked, all I can hope to do is to suggest a few side issues, which may provoke controversy far more valuable than anything I can say.

For, new though the art of reproduction by process is, it is already diverging into a hundred channels, and has its dogmas and its schools—as diametrically opposed to each other upon vital questions—as could be found in any subject an Englishman deems worthy his attention. Not merely do artists differ on results, they are by no means agreed on methods—not only do craftsmen squabble over details, they fail to unite on matters of the first importance.

Roughly speaking, those interested in "process-work" may be divided into two camps. Those who believe that nothing

can be produced to-day better than the work of past centuries, and holding the ideal of the past to be unassailable, regard any attempt to modify it as flat blasphemy; and the other school—who, believing that altered conditions imply amended ideals, would fain open their eyes to all the defects of modern methods, not to condemn them merely, but to discover, if possible, ways to improve and perfect them.

It would be hard to think of any artistic topic with ideals more widely separated than, say, the Kelmscott Press edition of Chaucer, with its hand-made paper—archaic ornamentation and antique type, symmetrically disposed on its pages—on the one hand, and the latest French or American *edition de luxe*, with its shiny paper, its fine woodcuts, or half-tone blocks, and its erratically arranged page, with illustrations splashed here and there, straying into the margin and at times, in pale shades, wandering underneath the type itself.

One is forced to own that the conditions of modern printing—especially those that concern the periodical Press—forbid a return to what we may conveniently call the Kelmscott manner. We may prize it as the perfect representation of an ideal that was achieved when printing was a fine art, and regret that for the future it takes its place with the arts that appeal to the classes rather than to the masses. For the attempt, excellent as it is, seems foredoomed to follow a not dissimilar effort to revive Gothic architecture in our daily life. We all know how, a generation ago, the casement, and the sash window, the pointed arch and the square lintel, the interior of unadorned brick, with open timbered roof, and the plastered walls and ceiling, fought for the mastery. The rows of so-called Gothic villas in our older suburbs cease to charm us to-day, their spikey fascinations tempt in vain. The ugliest Georgian house satisfies us more, because we see now an arbitrary attempt to adapt the externals of the surroundings to a past style was beginning at the wrong end, and that, after all, the art which accords most easily with the conditions of daily life, and the needs of the average citizen, is more likely to enshrine whatever art may be floating in the air at any period, than a deliberate attempt to be artistic in uncomfortable or archæological ways.

The conditions of our time, requiring as they do rapid production, and large numbers of impressions, with lavish illustrations, not merely of artistic, but everyday subjects, may be deplored, but it is wiser to recognise their supremacy. It does not seem disloyal to the ideal which ruled in the 15th and 16th centuries to accept machine-printing and process-blocks, any more than it is acting disrespectfully to Westminster Abbey to live in a house with gas, electric bells, and as much common comfort as the jerry-builder will give us.

Instead of trying to raise illustration by retracing our steps, and trying to be imitative 15th century—endeavouring to make a system which sufficed for a simple civilisation work under quite new conditions—would it not be better logic to accept machine printing, shiny paper, the process engraver and his works, and by mastering these new conditions—as the artist most assuredly can master any conditions if he set his mind to the effort—to create new ideals, and set up new standards of taste and beauty. Possibly, to do so, must be to give up certain forms of expression very dear to many of us. We are the most sentimental nation under heaven. We prize ancient faults far more than modern virtues. But there is something the reverse of despicable in fighting with circumstances. To create a new ideal of a perfect book, with its pages illustrated by modern methods, printed by steam-power, and produced at moderate prices; to leave such a standard, that future ages, removed from the strife of tongues to-day, should deem characteristic of the twentieth century, and beautiful because it fulfilled harmoniously the conditions which called it into existence, seems worth trying for—worth many failures by the way.

For can anyone declare that the art of illustration, or, indeed, any art, was the secret of any one age. What we do see is that the innovator banned by some of his contemporaries, who clung to past tradition, has often survived, when the orthodox imitators of earlier ideals have ceased to be reckoned of any account.

To-day we are in the full swing of process reproduction, so much so that wood-engraving seemed but lately to be dying out; except, perhaps, in America, and, in a few instances, where artists, such as Timothy Cole, Ellbridge, Kingsley, Charles Shannon, Charles Ricketts, and a few others, engraved their own blocks. Yet the last few months have witnessed a notable effort to bring it back to popularity in France and England; with that, however, we are not concerned to-night—but with the reproductive photographic methods for typographic printing. Of the various processes

employed in book and periodical illustration to-day, there are, roughly speaking, two classes, which are in general use—line work, for direct reproduction, and "half-tone," for the reproduction of wash drawings. The first, spoken well of by all men—the latter, a bye-word—a thing for every critic to jeer at.

Taking the simpler process first, "to draw in solid black lines upon smooth white paper" is still the popular advice of the process man to the artist. His aim is naturally to get a drawing that will reproduce easily, and yield a faithful result without undue pains. Add to this a protest against too great reduction, a caution against employing parallel lines too close together, or isolated fine lines which will inevitably thicken, and, above all, a warning never to use grey lines—such as an exhausted pen is apt to yield with many varieties of ink—and one feels the whole of the popular teaching on the subject is included. On the other hand, the pen-draughtsman, eager to obtain more subtle effects, is inclined to rebel against these restrictions, to demand the freedom of using grey lines, and to mix up pencil touches with ink, if he be so inclined. Indeed, some artists seem to feel their one aim is to set the engraver a problem full of difficulty, and bid him improve on the effects they desire. Looking askance at both artist and engraver, the publisher is apt to draw a hard-and-fast line of so much "per inch," and to grumble at any over-charge; so the triangular duel between these conflicting interests is fought daily in many offices.

It is hardly necessary to go into these three sides of the subject here, indeed, only an expert quite sure of his own position could exploit any one aspect of it adequately. Yet, leaving the debateable land, where commerce and art are always struggling, one may claim that a new technique for pen-drawing has grown up of late years, which has so far had scant justice done to it by many critics whose ignorance of process is no excuse for the very unfair criticisms they offer. A pen-drawing may be excellent from the process-man's point of view, and may so far imitate the style hitherto in vogue for woodcut to satisfy the older school of critics, and yet miss all the newer effects which are the joy of many students of the art. It is easy to dismiss the modern school as the work of a few geniuses who, by incessant practice, have become proficient—although it is a curious charge to urge to the discredit of a man that he is a genius who has taken infinite pains. Yet because it would be obviously foolish to advise any young artist to imitate the mannerisms of the style of any artist, we hardly solve the question by advising him to go back to the days of no style in particular; or by bidding him be content to imitate wood-engraving rather than to rely upon pure pen-drawing effects.

In drawing for process, it seems necessary to warn beginners to shut their ears to most excellent advice of most worthy people of past days *who were talking of quite another subject.* Nor must reference to the splendid school of wood-engraving, which both the foes and friends of modern pen-drawing agree to praise, be held to constitute the final court of appeal. The drawings we think so admirable did not escape abuse from contemporary critics. Take the following passage for instance without its context, and it sounds like one of the furious onslaughts on our younger artists we meet not infrequently to-day:—

"The cheap popular art cannot draw for you beauty, sense, or honesty; but every species of distorted folly and vice—the idiot, the blackguard, the coxcomb, the paltry fool, the degraded woman—are pictured for your honourable pleasure in every page, with clumsy caricature, struggling to render its dulness tolerable by insisting on defect—if, perchance, a penny or two may be coined out of the cockneys' itch for loathsomeness. . . . These . . . are favourably representative of the entire art industry of the modern press—industry enslaved to the ghastly service of catching the last gleams in the glued eyes of the daily more bestial English mob—railroad born and bred, which drags itself about the black world it has withered under its breath. In the miserable competitive labour of finding new stimulus for the appetite—daily more gross, of this tyrannous mob, we may count as lost beyond any hope, the artists who are dull, docile, or distressed enough to submit to its demands."

This diatribe, which had for its text the current number of the *Cornhill Magazine,* where Mr. Ruskin was writing, covers several pages of his "Ariadne Florentina," wherein he goes on to the conclusion that, "for total result of English engraving industry during the last hundred and fifty years, he was unable to get a single piece of true, select, and comprehensive art to place for instruction in any children's school."

If, in 1876, the great art critic thought thus of the English school of wood-engraving we now appraise so highly, what matter if lesser men to-day regard the modern art of pen-

drawing and process reproduction with somewhat similar contempt.

But this is only by way of warning to those who say that any cut and dried style of pen-drawing or woodcut has finally perfected a type for all successors. The man who has within him the instinct for drawing in black and white will ultimately find his own style, whether he employ the black blot of Vierge, the broken brush line of Japanese art, the finely-modelled lines of Marc Antonio, the attempt to work in pure line of one school, or an effort to give masses and values, made up by lines unmeaning in themselves which distinguishes another.

If this most important question of style be too great to discuss, on the other hand, it is not necessary to-night to go into details of the best ink, the most suitable papers, nor even to consider the important question of reduction—these things are excellently set out in many useful text-books. One man wields a brush with greater facility, another prizes a reed pen, another a Gillott, another a glass stylus—all these tools have their champions. But no one ever yet found the implement that ensured a good result: that secret lies at the other end of the pen, in the hand and brain of the artist. It would seem obviously to the artist's interest to set down lines that experience tells him will yield the result he wishes. If, for special reasons, he wishes to obtain unusual effects, it is hardly fair to complain that the engraver is to blame should he not succeed at the first attempt to secure them. Some firms, as we know, take a pride in overcoming difficulties—which pride often flaunts its unwelcome presence in their invoices—others, bent on keeping down expenses, do the best within limits and blame the artist for the failure. The game of setting problems for engravers, amusing to a cynic, is hardly so full of fun to the editor or publisher, who is not inclined to accord to all his contributors the attribute of genius, which rightly insists on making its own rules.

In face of all attack, one may venture to stand up for the popular illustrator, believing that, reviled by many in high places of criticism to-day, his best examples will survive to attract the praise of *connoisseurs* of the future.

It was Mr. Pennell, I think, who said that "artists who show their work to the people through the Press, are doing as did the masters of other days who spoke to the people through the Church;" and it seems no unduly sanguine prophecy to believe that of the best art we can produce to-day, a large proportion will be found in the popular publications of the hour. The same qualities that are needed for a good etching, which wears the purple of a recognised nobility, are required for what is even now considered its plebian descendant, a good pen-drawing; but, whereas in the etching the fat-inked line of the printer will give you even more than you expected, and, if you are so minded, *retroussage* and other tricks may eke out the effects of your drawing; here we may be fairly sure that the first block, printed by the best process, will rarely, if ever, surpass the original. The actual relief of the ink on the drawing, slight though it be, is a very important factor; and this is not apparent on the smooth surface of modern books

One could wish that for the sake of satisfying the eye, a method the reverse of hot-pressing could be adopted to destroy the shiny smoothness of the printed sheet to-day. Especially is this objectionable when the ink used has a lustre of its own, a metallic purple sheen which seems inseparable from some of the best halftone printing. But although the decorative school can enjoy the luxury of hand-made paper, the artist of actuality, the illustrator—as distinct from the designer—may count himself lucky to get fairly good printing, even when he has accepted the inevitable smooth paper, and the ink which produces the best results.

We all agree to consider the *Century Magazine* a typical example of excellent modern printing. In a conversation with Mr. De Vinne, he attributed its success, in great measure, to the American method of printing with a hard bed—so that the impact was almost a percussion, rather than an impression.

Slow as English printers are to move out of their groove, there can be little doubt that both process blocks or fine woodcuts demand this style of printing, and that ultimately it will come to stay. Consequently, those who would control the coming fashion will hardly do so by holding aloof and resting content on the laurels of their old superiority in the days before process. If so, their power may slip into other hands, until we find the purely commercial ideal influencing the whole method. Therefore, it seems wise to warn artists against this certain change at no distant date, and to prepare them to face the American ideals, and do their best to remove its ultra-pretty features

by working its methods on broader and more really artistic lines.

But although drawing by pen and ink is the chief method for the direct process, there are others which in capable hands can be trusted to secure most excellent results. Of course, the clay boards, the mechanically tinted papers, and similar devices can be most disastrously employed; but artists have before now—notably in the *Courier Français*, the *Chat Noir*, and other French papers—not merely escaped disaster, but used these prepared boards, or even the added tint—Day's shading medium—which was an offence to a recent speaker on this topic here, with admirable results.

A very safe way to ensure accurate reproduction of a chalk drawing is afforded by using lithographic chalk on a sharp grain paper, not necessarily of extremely coarse texture. The oily nature of the chalk seems to prevent those lighter touches which yield greys in the original, and in the block either disappear or come out solid blacks—in either place to the detriment of the work.

With this facsimile chalk-work great reduction is undesirable, as the dots (shown by a powerful magnifying glass) clear and distinct, which build up equally the lightest and the darkest tints, cannot be reduced without great change—they vanish or else run together in masses, either result confusing the intended effect.

Fine lines are hardly possible in this work, unless it is treated on a larger scale; but, beyond giving a mixed result not always pleasing, there is no mechanical objection to added touches by pen or brush that will supply those sharper accentuations of forms which are very hard to secure when working with the comparatively blunt point of this lithographic chalk upon rough paper.

To give an artificial grain to a smooth paper, some draughtsmen have worked with chalk upon a thin, hard paper (not unlike that used by typewriters) laid over a very rough piece of "Whatman" or the cloth cover of a book. You all know how easily a pencil rubbing of the pattern upon a cloth binding may be taken—in this case, the grain of the cloth is relied upon to break up the lines. The advantage consists in the fact that when the finished drawing is pasted upon a smooth board—the surface offered to the camera is smooth. Only those who have had much practical experience of drawings and blocks can realise what an enormous difference this apparently secondary factor has in the result. The ordinary shiny and unattractive silver-print photograph, and a platinotype or bromide, which people, who know no better, call an art photograph, give quite different results, greatly in favour of the silver print. The same principle obtains with the smooth paper.

Another form of direct work may be produced from drawings made literally upon the photograph itself, upon a special print made upon salted paper. When the drawing is blocked in, the photograph is blacked and finishing touches are added. For work involving much fine detail—especially with complicated perspective—of such subjects as interiors of florid buildings, or a group of houses seen in acute perspective, this method offers a legitimate aid to the illustrator, especially if he be working against time.

Other tricks such as "splatter" work and the like need not be mentioned. Of these it all depends who uses them. Nothing is heterodox to an artist; he makes the meanest things obey his purpose. Everything, however, justified by precedent, is capable of being used offensively in non-artistic hands.

It would serve no purpose here to go into technical details, to consider, for instance, to what extent cross-hatching is desirable. Personally, it seems to me, if used to imitate the method so frequent in debased wood-engraving it is undesirable. Indeed, for the freer art of pen-drawing for process, to bind itself within the limitations of the older methods is obviously absurd.

With regard to "half-tone," we find "process" in its weakest, and also in its most popular form. It is unquestionably beloved by the people to-day, and also barely tolerated by artists. Indeed, half-tone is the favourite object for attack by nearly all the exponents of the higher criticism; and it is a tempting subject for ridicule. The "moral pocket-handkerchief," as it has been called, with its flat, grey surface, its ugly, mechanical net-work, and its fatal facility for multiplying the cheap photograph from life—small wonder that it has become the scapegoat of photography, against whom every man's hand is raised. When one studies the blocks that illustrate the dozens of Academy guides and special supplements, especially those printed in pale shades of violet, green, and magenta, one feels the only advice to offer to those about to draw for half-tone reproduction is the classic "Don't."

Yet, here and there, we find blocks, quite as good as those produced by the imitative school of wood-cutting that preceded them, which

were employed freely in America, and jealously admired here but a few years ago. As the half-tone engraver to-day is equal to anything you can offer him, one need not say much of the preparation of drawings for this class of block, beyond a warning that as the white network has a trick of lightening the darks, and lowering the lights of the original—that it is wise to draw in a more violent key, with exaggerated contrasts of lights and darks. It is advisable also, now that the camera registers too faithfully any alteration of colour, that the same pigment be employed throughout the drawing, whether it be in oils or water-colours; otherwise, if black and dark brown are used together with dead white and blueish white, the block resulting will record these shades which the artist only intended to appear as different "values," not as different colours.

But the half-tone block at its best may be left to confound all its detractors. On the walls here is a reproduction of a photograph of a carved wooden altar piece, by the Swan Engraving Company, which not merely surpasses any woodcut, but beats the most perfect platino-type photograph—for strength and delicacy combined.

The tone-block as it leaves the process-worker's hands seems to have reached its limit, and for advance we must look for artistic development in the added work of the graver. Now, handwork upon the block, until quite recently, has merely added fresh horrors; the cut out backgrounds white, with the figures in harsh, untidy, silhouettes against them, the coarse white scratches, and the patchy effect of the engraved work upon the etched, has been preposterously absurd. Here is an amusing example of the touched-up block and the untouched.

The remedy appears to be in the artist's hands; he must learn to use the graver, himself working on his block, as some artists—Mr. Harry Furniss for one, I believe—do to-day. Then he might reasonably prepare his work accordingly, and leave certain details for after touching up. For instance, the hair of figures might be left in a mass of black, or certain shadows put in with solid washes, the white lines to be added afterwards. It is quite easy, I believe, at a particular stage of half-tone to burnish down the white net work in given parts, and to leave in their place solid blacks.

Judiciously employed, these masses often give vigour to a block, and whether prepared with a view to lightening by hand-work, or deliberately planned as solid masses to stay, there can be no doubt as to their value in certain cases.

The mania for great reduction is possibly nearly exhausted, and one can only hope it will never revive. A specious prettiness and preciousness it had, but the temptation it offered to slovenly drawing, and its forlorn dependence on the printer to redeem the result from being a mere muddled smudge, would alone suffice to condemn the practice. When a drawing the size of half a page of the *Times* was reduced to the dimensions of a postage stamp, the *reductio ad absurdum* was surely complete. Yet, if report be true, many of the vignettes that illustrated the popular series wherein "Tartarin" and "Madame Chrysanthème" appeared, were subject to some such reduction. The dainty liitle woodcuts which seem to be in imitation, or at least in rivalry, of process, by Florian and others, such as have been appearing in "Le Bambou," show a new departure probably destined to be highly popular. For myself, I fail to see that they are a great advance on the best half-tone. They certainly appear to print better, and at first there is a charm in finding the lines of the drawing full of interest in themselves, but, after all, they are the engraver's lines and not the artist's. True, in the best instances, they may be even better than those the artist put down; but one may be sure that, once the game becomes widely played, the second-rate engraver, the mere mechanic, will cut away the refinement of the artist's drawing, as he chopped it out of existence in former days.

Although for special decorative reasons—such as the Birmingham school rank so highly—it is quite possible to imitate a Durer woodcut, so as to deceive the very elect, there seems no particular virtue in so doing. Still if this be the object, it would be quite legitimate to draw it in white upon black paper, as indeed several artists of this school do. Such a method they say is more akin to hewing out the whites on a wood block. This may seem a fanciful explanation, the truer one being that if you are working in this way you can hardly help simplifying your forms, and endeavouring to get as much effect as possible with comparatively few touches. For this reason working in white upon a darkened ground, is likely to keep the designer more near the spirit of the archaic school he desires to imitate.

Yet it is but fair to say that the one school of English art (since Constable) which has

provoked the sincerest flattery of imitation from Continental artists is the so-called Pre-Raphaelite school, which in all its different manifestations—from Rossetti to Miss Kate Greenaway, from Blake and Mr. Walter Crane to the Birmingham school, and Mr. Aubrey Beardsley has already influenced French and German contemporary art to a considerable extent, while modern Holland and Belgium are entirely fascinated by its methods.

We are told that this decorative line is the only one that will accord with type, and stand in due relation as part of a perfect page. Granting this claim to the utmost, it seems to me you have only granted that a certain form of page has realised one perfect ideal of symmetry and proportion, which precedent has established as satisfying our taste completely. But that this ideal is the only one, and that beauty may not be sought in connection with any other page of type, with fine woodcuts, or even the much abused half-tone is quite another question. Because many of us delight in the older ideal, and are quite willing to endorse all that can be said in its praise, I fear we are weak enough to allow all other ideals to be tacitly forbidden. It seems to me that if only an artist of authority would defend the modern page at its best, and point out where the type and illustrations at present failed to harmonise, and would analyse the question of vignetted as opposed to framed illustrations; would decide whether the rigid rectangle of the drawing with a set outline was or was not more pleasant in connection with the whole page than a vaguely softened outline straying, maybe, into the margin; and, above all, would try to formulate the most pleasant proportion of the face of the type to the illustrations, something might be done to establish a new ideal. Possibly, as the heavy line of the old woodcut accorded with the heavy and beautiful type of the period, so now with a more delicate scheme of illustration, relying upon the values of masses rather than upon lines, whether produced by fine woodcut engraving or the half-tone process, we must endeavour to use a lighter-faced type, perhaps more closely set together, to gain a silvery mass of grey, rather than parallel lines of dark grey with vivid white lines separating them, which is the effect of the average page of type to-day.

For the art of drawing for process reproduction should, I think, find the artist keenly alive to the final presentation of his work. It seems a most desirable thing that he should be interested far beyond the receipt of a cheque from the publisher. Indeed, the future of illustration is only hopeful if we look forward to the co-operation of artist and art editor or publisher in a way undreamed of in the past.

It should be deemed absurd for a publisher to order so many drawings of a certain size, without telling the artist the style of the book they are intended for. Or if they be destined for a periodical which more or less keeps a permanent standard of arrangement, then the artist should know before if he is to fill a whole page, or half, or quarter, as the case may be. He should know the type to be employed, the surface of the paper, and the colour of the ink. If half-tone is to be used, he should be consulted on the reduction of his drawing, whether a coarse or fine grain is to be used, and above all in work of any pretension he should be allowed to select a decent firm of engravers, and to be assured that printers who undertand the delicacy of the half-tone block are ultimately to be responsible for the production.

The mere mention of the printer is touching upon the most sore point of all, because there can be no doubt that he is at present the drag on the whole machinery. Good drawings are to be had, good blocks are to obtained—but good printing in the modern style is, if not unknown, at least rare.

How far this is due to the ink, to the varying temperature of our offices, which are rarely heated thoroughly, is not easy to settle. Practical printers in America, with whom I have discussed the subject frequently, generally attributed our non-success to one of these two reasons. Mr. De Vinne—as I said before—went further into the matter, and attacked our paper, ink, and, above all, our custom of using a yielding, instead of a solid bed. He acknowledges that for such book printing as the Chiswick Press has turned out for so many years, England was still easily first.

When editor of an American magazine, it was my duty once a month to go down to the printer's and there, in the office itself, to see the pages upon the press, to look over the locked forms and suggest slight changes in position of the blocks, or alteration in their titling, and so to make a final attempt to bring the whole page into that symmetrical condition which defies all rules, and can only be done by instinct. I wondered how much of the unsatisfactory state of English printing was owing to the separation of the various departments in publishing a book or periodical, which should be under

one control. If the paper itself is ordered by one member of a firm, the blocks by another, while a third is responsible for passing the sheets, and the printer is allowed his choice of ink, his own disposition of the blocks, in fact, to put the impress of his taste on the work, can we be surprised that the result is not homogeneous? One mind should be apparent through a book or periodical. If it could be the artist, it would be ideally the best; but a number of artists must needs be employed on a single volume in certain cases, and, as their time is too valuable to be spent on practical details outside their craft, even if one granted their agreement in these matters, there must needs be an actual art-editor—not merely one nominally so-called, but a man fairly conversant with all those questions involved—one who could be trusted to consider every one of the thousand and one items which go to build up a beautiful book. The binding, the end papers, title-page to colophon, arrangement of blocks, every detail small or great—all should be in accordance with one standard of taste. If such a one were wise he would keep himself in touch with the artists who worked with him, and by informal conferences let them know beforehand such matters as would affect their drawings, and in turn obey their wishes as to the reduction of drawings, the placing them in the page, and the style of titles to be printed underneath, and all these trifles which make or mar perfection, and, on the other hand, he should work in equally intimate relation with his printers, and be a constant visitor to the machine-room, supervising all.

This may seem a side issue to introduce into drawing for process; but it is in ways like these that half the mischief lurks to-day. What is everybody's business is nobody's business; you may as well expect a firm to write a sonnet, as its members, acting independently, to produce a perfect book. One could name not a few magazines where money is apparently freely expended—where capable artists, good process engravers, and adequate printing, unite to produce a chaotic medley, that seems to have no method in its muddle. On one page you see an idea of balance and a sense of "colour" in the disposition of type and process blocks, in the next the office boy was apparently left to stick the pictures anywhere on the page, and the printer told to fill up the rest with type. Of the constant intrusion of the photograph from life with all its unselected mass of detail, among reproductions of drawings much might be said. The awful examples of certain American magazines that have illustrated fiction by photographs of posed models, is only one step more in the direction of artistic depravity. For views, passing events, and a score of other subjects, the photograph is most welcome; but when it is set in rivalry to the artist, even the most tolerant must protest. We object to an undue use of the costume model in paintings, but at its worst the custom is praiseworthy compared with the figure posed by way of illustrating poems or stories. In such a practice is surely the nemesis of ultra-realistic art — the realism that defeats its own end, and becomes more hideously conventional than the worst efforts of romance.

Photogravure is too far removed from the subject to be more than touched upon here; the almost universal preference shown by artists for their pictures to be reproduced by this method, in place of steel or copper engraving, mezzotint or etching, is sufficient to urge in its defence were any needed. In more sumptuous editions of late years, it has been employed for the reproduction of wash drawings; but the result, in many cases, is not so far in advance of a good half-tone that it warrants the large increase of cost. For reproductions of engravings, pencil drawings, and the like, it may be fairly claimed to be absolutely the best mechanical process.

Colour printing by process blocks is obviously upon us. Of the curious achievements wherein the colours are dissected by mechanical agency and the resultant negatives made into blocks and super-imposed in three or more primary pigments, so as to yield a naturalistic effect of colour, silence is the kindest criticism. As scientific experiments they are most interesting; as commercial products they are very promising; but so far as art is concerned, the worst chromo is preferable so far. Although there are not wanting signs of better things, such for instance as a reproduction of a water-colour sketch, given with the February *Artist*, reproduced by Messrs. Hare's process. Possibly, for patterns and reproductions of coloured drawings *made with a view to their special requirements*, they will become widely and not undeservedly popular. Then it will be necessary in any chat upon drawing for process to give a series of hints on the best pigments and their rightful limitation—for making originals to be reproduced in this way. But if we look around and see what has been done by woodcut printing in colours in the past, the Walter Crane toy books, or those wonderful

Japanese prints which are an endless source of delight to Western minds, a hopeful future unfolds. Possibly the gradation of tint, which is the charm of much Japanese work, can never be hoped for from machine printing; it is the work of the artist craftsman, not of the machine, however deftly guided. Stippling is a poor substitute, and super-imposed colours, except for bold work, like posters, has a peculiarly unpleasant effect.

If, however, we boldly accept the mosaic of solid colours, with or without those black separating outlines, which govern a large mass of Japanese prints, and seem to be equally applicable to the decorative school of English art, it suggests a possible method that might even take its place among the ordinary commercial products of the day, and yield excellent art. But for such printing as the earlier Walter Crane toy books, it seems to me that hardly anything has yet been attempted by process blocks. If we are intent to avoid superimposed colours, and to be chary of stippled and mechanically-produced shades, good effects might be realised even by machine-printing and cheap process blocks.

Like it or not, cheap and rapid colour-printing is upon us. Paris has already its daily paper illustrated in colours. Regarded independently as a specimen of typography, this journal may not escape criticism. But when you consider that 6,000 copies an hour are struck off from a rotary press, and 40,000 issued daily, it is astounding. The particular rotary machine which accomplishes this result is being duplicated for London, and I am breaking no secret in saying that by its aid popular colour-printing, in ways hitherto undreamed-of, will shortly assume a prominent place in journalism.

A modification of colour, which consists, roughly, of two half-tones, the one prepared for the contours, the other for the modelling —has much to recommend it, especially for the reproduction of oil paintings, so far the ideal seems to have been to imitate a collotype. Sometimes, as in a reproduction of a picture by Mr. Waterhouse in *The Studio* for January, a very fair rivalry results. Now a collotype—I speak after Mr. Frederic Hollyer, whose opinion is entitled to peculiar respect in such matters—is, perhaps, the best of all reproductions by mechanical means; that is to say, the next best thing to a good platinotype or a silver print. But it is far more costly and demands more time for its production. The advantage of this half-tone method is that it can be worked in conjunction with typography, not necessary even on separate sheets. Therefore, this half-tone, printed in two shades, may have a not dishonourable future before it. And in the reproduction of paintings, indeed, if the artist properly understood its limits, there may be possibilities in it which would give to the half-tone more vigour and more atmosphere, and fit it for the illustration of modern books where high finish is demanded.

It has seemed unnecessary to refer to the triumphs of native process work—some examples of which, by the courtesy of various firms, are on the walls to-night. But a little time ago it was almost essential to send work abroad because of the unequal level of British blocks. Now there are several firms who can rival the best French or Austrian work, and each day sees a higher average in the better class work all round.

There is another question outside my text, as indeed most of this rambling discourse has proved to be, which should be taken up in earnest by some society of importance. I mean, the preservation of the originals of the drawings produced literally by hundreds every week for our periodical publications. Some day we shall regret the carelessness which has already allowed so many to vanish no one knows where. Some few firms, indeed, sell now and again such pictures as have a certain independent interest of their own. But in almost every office of London at the present day, piles of drawings are accumulating, some of which, we have a right to expect, will be not without interest to future generations. Who would not prize the originals of thousands of woodcuts of the days before photography, when the drawing perished in the cutting. Now this does not happen. Before it is too late one may hope that a number of contemporary drawings may be rescued and preserved in some museum or gallery for future reference.

We must not, however, ask too much of contemporary periodical literature—not every fifteenth century book is a masterpiece, not every etching, old or new, is a Rembrandt or a Whistler. If one in a thousand—one might say one in ten thousand—illustrations to-day find its future immortality in these ephemeral publications, we shall have a fair number to justify the existence of the rest. Nature is careless of a million failures, so one survives, and art need not be expected to be more fecund.

Personally, it seems to me that the present

period is for illustration what the Elizabethan was for lyrical poetry. There in a hundred books of airs you find words of songs any one of which might make the reputation of a poet to-day. So it may be that Mr. Pennell's anthology of pen-draughtsmen will be to future students what "Tottel's Miscellany" or Mr. Bullen's charming anthologies are to students of poetry—priceless collections of the work of artists, many of whom would have been absolutely unknown but for this preservation of their ephemeral work.

Possibly this period will stand out not as the age of fresco, or the age of oil or water-colour pictures, but as the age of black and white illustration, which, for the most part done without thought of immortality, gained it unawares.

A selection of specimens of English process work, kindly lent by Messrs. A. and C. Dawson, the Gilling-Walpole Company, Messrs. Hare and Company, and the Swan Electric Engraving Company, were exhibited during the evening.

DISCUSSION.

Mr. J. PENNELL said there was really very little to take exception to in this paper. At the beginning he thought it was going to be very amusing, and that the reader of the paper would pitch into French and American printing and the shiny surface paper, but, as he had explained, that was the best thing they could get, and that every Frenchman and American would give the paper up to-morrow if they could get anything which would print half-tone blocks better. In fact, if anyone could produce a paper on which these blocks could be printed, which had not such a smooth surface, he would make his fortune. As to the eccentric mode of sticking drawings in a page, he must confess he had sinned in that way himself, and at one time he thought it was the most beautiful thing to drive a coach-and-four through the middle of a page, but most Americans had got over that, and they must now look to the most popular English periodicals for the choicest examples of that sort of abomination. In some of the largest shops in Fleet-street they would see things which would be scorned in America. There had been a note of warning with regard to wood-engraving dying out, but that was sounded by people who knew nothing about it. Wood-cutting was a lost art; but wood-engraving as a fine art was in no danger. There were never so many good wood-engravers as to-day, and there never were so many great artists who were wood-engravers, and they never had so good a chance. As to the trade of wood-engraving, which had been injured by process, that was a different thing. It was not an artistic matter. In wood-engraving, as in everything else, it was the case of the survival of the fittest. The trade was in a bad way, but the man who could do good wood-engraving to-day had the opportunity of making a good reputation and a very good living, and he did not see what more he wanted. As to Mr. Ruskin's criticism of the drawing in the *Cornhill Magazine*, it was always amusing to see what Mr. Ruskin said. He was usually wrong with regard to anything practical, and he thought Mr. White might have given a little better example. If he would take Albert Durer's journal, when he first went to Venice, he would find that Durer was driven almost mad by the Venetian artists who bullied and annoyed him, said his work was abominable, simply because it was not like what they had been accustomed to see, and soon afterwards they stole all that they could from it. Three or four years ago everybody pitched into American wood-engraving, but now when it was said to be dying they praised it. With regard to the drawing on a book cover, he had never thought of that trick, but something of the sort was to be patented, and he believed the gentleman had provisional protection for it. He certainly should not buy the patented appliances, but should use a book-cover which would answer equally well. He should like to know where they could get those photographic prints which had been referred to for bleaching out. He had never been able to obtain them in London. Another thing he had seen within the last few days was the enormous advance made in London in half-tone blocks. One process man had invented a scheme by which he got his whites without any stopping out or cutting out. They came apparently without any trouble. In fact, inventions in process reproduction came out every day—or rather two in a day. By the latest invention (which is only a rumour as yet), sensitised paper on a reel was passed in front of a camera, and, without any artist or any printer, the finished book produced. There was a very interesting article in last month's *Century*, by Mr. Fraser, who suggested a very good plan for producing half-tone blocks by second-rate wood engravers. In the last number of *Scribner* there was a portrait by Mr. Hamerton, wonderfully well done in this way; the border was engraved on wood, but the portrait was a half-tone block in which all the half-tone was cut out, except in a few places. He agreed that if there was an art editor like that ideal person Mr. White recommended, the artists' lot would be much improved; but he did not know any man in the world who possessed the qualifications he demanded. Finally, as to preserving drawings, that was a subject which deserved attention, but it was already being taken up. During the last year, one of the great museums in Australia had started this idea, and the gallery in Melbourne had already commenced a collection of black and white works, and they had there the work of some of the best men. It was

proposed to have an exhibition next month in Liverpool, solely of black and white drawings; but it was as well to mention that many artists doing the best work were beginning to have a very good notion of the value of their designs, so that those who wished to obtain them had better do so at once; in fact, already what could have been obtained for a few shillings a short time ago, would now fetch some pounds.

Mr. HORACE TOWNSEND said this was a most interesting and thoughtful paper, but the first exception he took to it was that the author seemed inclined to hark back to the better work done in the mediæval ages, and especially to the better printing, and seemed to excuse process work as a thing to be put up with, because we could not have what was better. That, he thought, was altogether wrong. The printing of to-day was very much better than it was formerly, and, more than that, rotary printing, which was looked upon as a regrettable expedient forced upon them by commercialism, would, he believed, in time to come, be found to produce better results than the most careful hand-work of byegone times with flat presses. The fight between the draughtsman and the reproducer had been going on for centuries, and just as to-day the artist complained of the process man, so, yesterday, he had complained of the wood-engraver, and it had been so in all time. He thought the artist ought to recognise the conditions of the process, whatever it might be, which reproduced his work, and then he would find, as he had in the past, that the very limitations imposed upon him might be made to help him artistically; a very good parallel might be found in the stained glass work of mediæval times; in the very limitations of their work real artists found their strength. He quite agreed with Mr. Pennell with regard to smooth paper. They had to put up with it because it was the only way in which they could get true blacks in their printing, and it was the absence of the smooth surface which had hampered their predecessors. Those lucky enough to possess Durer's wood-cuts would know that the blacks were very grey. Some time ago, Mr. Pennell told him that he had found one impression of those early masters which was a thoroughly black print, but that appeared to have been a lucky accident, and the artist never repeated it. Mr. White had poured out the vials of his wrath on the half-tone process, but he thought there was a great future before it. What process men were looking for he believed they would eventually find, viz., some way of differentiating the breaking up of the blacks. They were now broken up by a lined screen which gave the same size of little dot throughout the block, and this led to a mechanical smoothness and want of texture which was unpleasant, but he thought that would eventually be got over. As it was, the finer the screen, the less apparent that regularity became, and screens were, now-a-days, becoming finer, and better results were obtained. In one of the American magazines for last month there was a very clever application of half-tone work to a pen-and-ink line drawing, touched up in parts with pencil. The process man who tried to produce it by ordinary line process would have failed, but the result as a half-tone block was almost perfection, and it was probably the best result of mechanical re-production he had ever seen. The photographs which had been ruined by an attempt to improve on them he took a particular interest in, as they were used to illustrate an article of his own, and he remembered the agony with which he saw the proofs of the first block. That was a case, however, of touching up the photograph itself, and as that work was "made in Germany," the result was very ghastly. That did not touch the question of working on the process block itself with the graver, which he thought might be done with great advantage in most cases, as was done in France. English engravers were not allowed to do so by editors, who simply would not pay the price required.

Mr. J. JACOBI said he should like to say a word or two to illustrate the difference between American and English printing, especially with regard to half-tone blocks. He had the pleasure of seeing Mr. de Vinne a short time ago, who told him some of the conditions under which the *Century* was printed, and he found that the time and expense allowed here for printing was very small compared to what it was in America. There was not the same limit put there to the production, or the same hurry and bustle. Another important feature was the atmospheric conditions; for instance, he had been printing recently a magazine with a good many half-tone blocks, and during the last week, although they had facilities for warming the machines, inking slabs, and rollers, they could not get the "colour" to run. In America, he believed these difficulties did not occur to so great an extent. He understood that making ready a single sheet of the *Century* took two or three days, but nothing like so much time would be allowed here in London. Everything was rushed up into a corner, and they could not possibly take so much time. No doubt up to recent times English printing of these blocks had been defective, as they had been in the habit of making ready process half-tone blocks in the same way as they used to do wood blocks—they had done too much to them. Experience showed that if we could only get the right degree of hardness of impression or impact, first bringing the blocks up to a certain level, a better result would be obtained without so much overlaying. He thought the *Pall Mall Magazine* would compare very favourably with American work.

Mr. HENRY BLACKBURN said he had already given in that room his ideas with regard to this subject, but there were one or two points in the paper on which he might say a word. With regard to the

amount of reduction of drawings by process, there was no fixed rule. If you drew for a certain reduction, no matter whether it was great or small, you would generally get the result intended. In his own experience some of the best drawings had been re-produced almost the same size as the original, and others he had reduced to one-sixtieth, and in each case they came out as they were intended. With regard to printing, he was glad to say from experience that there was a great improvement in printing process blocks in England; the *Pall Mall Magazine* and the *Illustrated London News* were printed splendidly at the present time, and he thought that, both as regards paper and print process blocks were now having their due. What they wanted was that the best artists should take more trouble to learn the requirements and limits of drawing for process, and this was a matter of the utmost importance as so many of the best artists were now taking up drawing in black and white. He was quite with Mr. White in denouncing the pictures which were made without the aid of the artist. In a recent number of the *Artist* might be seen the picture of an old man, with a background and a number of details, all produced without the aid of the artist at all. The photographer was in fact taking the place of the artist and of the illustrator. With regard to the piles of drawings in the cupboards of editors, he could only suggest that the reason they were not distributed was that the editors did not like us to know how bad some of the re-productions were! There was no doubt that process re-production was developing, and that artists must watch it and take it more seriously than they had been accustomed to.

Mr. G. DAVISON thought a word might be said from the point of view of the photographer. Mr. Blackburn had referred to the necessity of the artist producing his picture in such a way that it might conveniently be reproduced, but it seemed to him that if the object of the picture, from first to last, were artistic, then this was altogether wrong. The work of the artist ought in such a case rather to be aimed at and worked up to by the man who was to reproduce it, and to do that, it seemed to him, it would be necessary for the artist who cared to be reproduced himself to become, in some sense, a process man to direct how the work should be done. Most of the work which had been referred to was not altogether artistic; in fact, it was intended for journals in which the illustrations were more or less of a record character, and had but little artistic value. When purely artistic work was intended, it should be printed on separate sheets and reproduced solely with the artistic object by photogravure. With respect to the argument that wood engraving was superior to half-tone work, it ought not to be forgotten that there was inherent in wood work a certain mechanical quality derived from the character of the material in which the artist worked. The photographic method might be made to reproduce more faithfully the technicalities, as well as the quality and character of the original works. In criticising half-tone block work, as it was seen to-day, they ought to understand the limit of its possibilities and watch its development. His feeling was one of wonder at the vast strides that were being made, and at the comparatively fine effects which were produced by half-tone relief blocks, even with coarse screens. It was said by Mr. White that in engraving drawings prepared in black and brown, the photograph rendered values inaccurately, but that was not so of necessity, it was the fault of the photographer. He might so choose his methods and tools as to ensure the true relative gradation in the result. He did not quite understand Mr. Pennell's question with regard to fugitive photographs, but if he understood him aright, he referred to what Mr. White said with regard to bleaching a photograph—first of all making a drawing over the photograph, and then bleaching the original photograph and leaving only the drawn lines. This could be done upon an ordinary bromide or silver paper. As regards the question, which had been alluded to, of photographic illustrations and their quality, if they based their judgment on the illustrations which appeared in the popular weekly journals, they might be doing a great injustice to what was possible in the artistic direction with the photographic camera. One of the most interesting points raised was that of printing on rough or smooth paper. The glazed paper was used because the printer desired it. It was well known that the collotype, which could not be printed with type, printed perferctly on rough surface paper, and gave a far better effect than on smooth paper, but he believed that a fair trial had never been given to the reproduction of half-tone work on different classes of papers. The printer had a certain standard, and required other people to work to it; but if an artist were to take up those processes and experiment with different qualities of paper, he felt confident he would find that the orthodox paper was by no means a necessity. Finally, he believed that the chief illustrations in nearly every magazine would be found to be valuable simply as records, and not as works of art, and from that point of view he thought photography could be employed in a way superior to all other methods. Any hand-work on a photograph for such a purpose would generally introduce a personal fancy or some individual vagary which would also reduce its value as a record.

Mr. T. L. HARE said he should like to say a word from the point of view of the engraver or process man. It must be gratifying to know that this subject was being seriously studied by artists. No class of people received more kicks from publishers and printers than engravers, on account of the bad results that were obtained chiefly due to ignorance as to the proper limits of photo-engraving. It was a recognised principle in most other branches of art that the artist should know what his limits were. The musical

artist when composing an opera took care only to write music suitable for the instrument which was to perform it, but hitherto it had been the custom of artists to treat this subject in a more or less contemptuous manner, and to imagine that anything they chose to send in to a publisher could be reproduced by the particular method they selected. Of course that was not so, and it was now being recognised. The artists themselves had as much to gain by recognising the limits of photo-engraving as anyone, for nine-tenths of the white and black artists of the present day, who were so deservedly popular, would never have been heard of had it not been for the development of photo-engraving. He was surprised to hear Mr. Jacobi refer to the difference between English and American printing, and to say there was more commercial rush in London than in New York. The idea of rush with regard to a monthly magazine was out of the question, and it was the monthly magazines which were so abominably printed. The *Pall Mall Magazine* had been made a great deal of, simply because it was the only one worth mentioning. All the rest were printed in a very inferior manner. He maintained it was not because of any climatic difference between London and New York, nor because of any difference in the paper, but because they had printers in New York, and in London we had none or very few. In a large establishment in London the proofs pulled off the machine would be considered magnificent, which in New York would be thrown into the waste-paper basket.

The CHAIRMAN said they had most of them gone through various stages with regard to process work, but at any rate he should like to express his own satisfaction at what process had done for a great many of them. He was interested more especially in ornamental art, and he must say they never had ornament engraved decently in this country. If anything ornamental had to be engraved, it was always given to an apprentice, apparently, but now, by process, they did get reproductions of ancient work which were excellent as records, if nothing else. It was no use abusing process, it had come to stay, and its future depended partly on the process man, and partly on the artist. It was pretty clear that engravers would have to supplement the actual mechanical work by some kind of hand-work if they were told to produce the best possible results. This was done to some extent, but it would have to be extended, and process men would have to devote their energies to making the work better, and not only to making it cheaper. With regard to artists, the class of draughtmen was forming itself; it had made some men individually, and apparently injured some men very much; but he hoped that good would prevail. He agreed with Mr. Blackburn that the draughtsman must sacrifice something of the quality of his drawing to the ultimate effect of his print, and there was nothing degrading in that at all. He who did not do that was very unwise. To say it was the artist's business to make the picture, and the engraver's to reproduce it, seemed to him to be taking rather an arrogant point of view which young men, at any rate, would not find answer with the publisher. It was clearly the artist's business to think how his work was to be reproduced, and to draw accordingly, not only in fairness to the engraver, but to himself. Mr. White suggested that some artists were working on the block themselves, and that seemed to him absolutely the right thing, and he hoped it would be done more. That suggested another idea. Why should not the artist provide the publisher with the block, not merely the drawing? Then he would work with the process man and he would be responsible for his own. That would be very much in the interest of the art, and also in the interest of the engraver, for the artist would be careful then, seeing that he had to pay for the block, not to put unnecessary obstacles in the way of the engraver. He agreed with Mr. Blackburn with regard to the reduction of the drawings; it was merely a question of the way a man drew. He knew men who protested that the drawing should be the size it was going to be published. Others said it should be a little longer, and others said if they drew it on a much larger scale you could not realise what it was going to come out. That was very much a matter of temperament. Some artists could not imagine what a drawing would be on a different scale, but others could. He had seen a cartoon half as high as that room reduced to three or four inches quite satisfactorily. One advantage about process was that it enabled men, not necessarily illustrators by profession, to draw for illustrations. In some of the American magazines a few years ago there were several illustrations from sketches in clay, reproduced by process, which were very admirable. He concluded by moving a hearty vote of thanks to Mr. White.

The vote of thanks having been carried,

Mr. WHITE, in responding, said he had not been criticised so severely as he expected. Indeed, when Mr. Townsend reproved him for pouring the vials of his wrath on "half-tones," he wondered if, adventuring into the field of photography, he had mixed the positives and negatives, for he intended to speak in favour of it. He thought he should have been blamed for speaking up for process, but he was glad to find that now-a-days everyone was ready to approve of it. Mr. Jacobi had referred to the temperature of an English printing office being against good printing, and he might say that all the foremen and some working printers in the American houses who were intensely interested in the discussion on English printing put it down entirely to the lack of equal temperature. In an American printing house the

temperature, he believed, was never allowed to fall below 80°. He agreed with Mr. Blackburn with regard to reduction. In every case, if possible, the artist and the editor should be well informed of the matter before the drawing was made. Mr. Davison thought the artist should not limit himself by the limitations of process. If you were speaking of the true artist who did what he must, not what he was obliged to for payment, he should agree that he should not be limited, but such cases were very rare. He might mention an extreme case of a drawing being sent in by a lady artist drawn in pale blue pencil on deep yellow paper. That was, at all events, not recognising the first limitation of the craft. Some limitation must be recognised, the amount, of course, must be decided by circumstances in each case. The Chairman's suggestion about artists supervising their own blocks was carried out in certain cases—chiefly in the case of the young men who had not too much to do, who sometimes spent a good deal of what they considered valuable time at the process makers in seeing to this question. There would come in his contention that the size of the block should be known beforehand, or the publisher might have blocks sent in too large for the page.

Mr. H. H. Statham writes :—My experience has been chiefly in regard to drawings for photolithography (line work), "ink-photo," and zincograph. In regard to line-drawing for photolithography I find the most common faults are a tendency to rely on the use of fainter ink for effects of distance, and a want of clearness and decision in lines used for producing shadows. It is difficult to get draughtsmen to understand that a distant effect, so far as it can be produced at all, can only be produced by the use of *thinner* lines, not by fainter ink; the defect of faint ink being, of course, either that it does not print at all, or only in a blurred and partial manner, or else that it comes out just as black as the rest, thereby entirely disappointing the draughtsman of his expected effect. In regard to shading, I think it most important that this should be done in cleanly-drawn parallel lines, not in irregular sketchy lines or in cross-hatching. In cross-hatching, the ink, in printing, tends to spread at the points of crossing of the lines, producing a blurred and confused effect. The employment of cleanly drawn parallel lines in shading is of the more importance when a drawing is to be much reduced in reproduction. Line-drawings will bear a surprising amount of reduction without losing clearness, as long as they consist of clean lines with a sufficient and well-defined space between them. When they are drawn too close together they will run into each other on reduction, causing dark marks or blots on the lithograph. In regard to the material for making the drawing, either Indian ink or a warm brown ink succeed equally well, but the Indian ink must be mixed thick and black, nowise inclining to grey. For the lithographic printing itself black ink produces the best result where the original drawing is a clear and firm one; but in the case of rather sketchy drawings the best effect is produced by printing them a rather light brown, as the want of clearness and the occasional blotching in the print is less noticeable than when black ink is used. "Ink-photo" is essentially a process for reproducing surface tints rather than lines. It is true that line-drawings which would fail entirely in photolithography, either from too faint ink or too sketchy a style, may be reproduced with fair effect in ink-photo, as also line-drawings in ordinary writing-ink (a charming medium for the draughtsman but a very bad one to photograph from). But the grain surface which pervades the ink-photo prevents anything like the true effect of a clean line. Washed drawings in monochrome, especially in sepia, where the contrast of effect is all produced by different shades of surface tinting and not by defining lines, come out admirably by the ink-photo process. With water-colour drawings, properly so called, the ink-photo result of course depends almost entirely on the nature and balance of the colouring in the original drawing. If the lighter surfaces or high lights partake of a yellowish tone, they will come out too dark; if the darker portions incline to blue, they will lose their force, and the balance of tone of the original may be almost reversed. What has been said about ink-photo, in regard to lines and surface tints, applies *a fortiori* to all kinds of what are called "tone-blocks." Here the granular effect is more decided than in ink-photo, and plays havoc with any small architectural or decorative detail; but, forcibly executed, washed drawings in broad surfaces of contrasted tone will come out very well in a tone-block, and the contrast of light and shadow is more powerful and effective than in an ink-photo. Line-drawings for zincograph are subject to the same conditions as those for photolithography, except that in these a severe and clean style of drawing is, perhaps, even more essential; for zincography, though a very useful, cheap process, is very hard and mechanical in effect and texture compared with the wood-engraving which it has so largely supplanted; and what appears a spirited and free pen-sketch in the original, will too often lose its look of freedom in the zincograph reproduction; it is best, therefore, to draw in a rather conventional and mechanical style for zincograph, as it will, at all events, reproduce that kind of effect but cannot be depended on to reproduce the effect of a free sketch satisfactorily. As an instance of the difficulty sometimes experienced in getting people to understand the conditions of making drawings for reproduction, I may mention one case where an eminent architect was having a drawing specially made for publication in the *Builder*, and consulted me about it, when I explained to him that a line drawing alone could be produced by photolithography and a washed drawing was the best for the process of ink-photo, and described the effect of each.

He sent a note afterwards with the drawing, saying that he had carefully attended to my instructions; and I found he had had an ink-drawing in fine line made first, and had then washed over the shadow portions with sepia, so that it was suited for neither process. In regard to brush drawings for ink-photo, it is best to do them on as smooth a paper as can be used for water-colour drawing, for the rougher the paper is the more "tint" it produces in the lithograph; the untouched portions of the paper, which should be white in the reproduction, get a dull grey or dirty tint over them, and the contrast of light and shadow is much weakened.

TENTH ORDINARY MEETING.

Wednesday, Feb. 13, 1895; SIR BENJAMIN BAKER, K.C.M.G., in the chair.

The following candidates were proposed for election as members of the Society:—

Bates, Matthew, Bromley, Kent.
Cowling, John Combe, Surveyor's-office, Urban District Council-offices, Cockington, Devon.
Holden, Timothy, 36, York-street, Broughton, Manchester.
Hoskins, Admiral Sir Anthony Hiley, G.C.B., 17, Montagu-square, W.
McCreery, James, 257, Albert-bridge-road, Belfast.
Maton, Leonard James, 21, Cannon-street, E.C.
Steward, John J., 457, Strand, W.C.
Ward, Colonel James, C.B., Junior Carlton Club, Pall-mall, S.W.
Wells, Sidney Herbert, Polytechnic Institute, Battersea, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Murphy, A. J., The Laboratory, 5, Carnaby-street, Leeds.
Pogson, Alfred Lee, Harbour Works Office, Madras.
Smith, Harold, Ingleside, Kenley, Surrey.
Struber, Frederick Pine Theophilus, Malpas-lodge, Torquay, Devon.

The paper read was—

LIGHT RAILWAYS.

BY W. M. ACWORTH.

A political philosopher with a turn for psychological investigations might find an interesting subject for study in the attitude of the English mind towards railway development. As a rule, we are anything but an over-cautious people. The love of speed, of record-breaking for its own sake, seems innate in our blood. We encourage our boys to play football, to bathe and to shoot, even to hunt, though the risks in all these pursuits, not merely to limb but actually to life, are quite considerable. Not a winter passes in which scores of lives are not sacrificed through venturing on rotten ice, yet no parent insists that his boys shall skate, as the old rhyme puts it, only on dry ground. The public in all these cases has emphatically made up its mind that the risk is worth running, that the game is worth the candle. In the case of railways alone a different point of view is assumed; here alone we seem to loose all sense of comparison, and act and speak as though we were a nation cradled in band-boxes and swaddled in cotton-wool. We must have absolute safety, cost what it may. If a railway accident happens, the Press teems with letters urging that at all cost such accidents must be made impossible in future, regardless of the fact that in railway management, as in all other affairs, life is a series of compromises; that railway development is impossible if safety regulations are to be made indefinitely elaborate, just as football would not be worth playing if no two persons were permitted to approach the ball simultaneously for fear of a collision, and hunting would be uninteresting if all the fences were levelled and the ditches filled up for fear of a tumble. Railway accidents seem to be placed in a class apart. The newspapers, for example, filled columns with descriptions of the accident at Chelford in the great storm of last Christmas Eve, in which some 12 persons lost their lives, whereas the deaths of ten times that number who were killed by falling chimneys and other equally preventable accidents due to the same storm passed practically unnoticed. It would be out of place here to go into the causes of this state of things. A cynic might suggest as the main reason the fact that those who talk about railways don't know, and those who know about railways don't talk; but a simpler explanation may be found in the fact that, just as a man in health knows nothing of the action of his heart or lungs and only begins to notice their existence when something goes wrong with them, so the monotonous regularity of the express which leaves Manchester every evening at 5.30 and runs into Euston as the clock hands point to 9.45 calls for no description. The work of driver and fireman, of guard and signalman, along its entire course, seems so mechanical and matter of course that it passes unnoticed, and public attention is only called to railways at the infinitely rare moments when something goes wrong, when the instantaneous contrast between the perfection of disciplined control over the forces of nature at one moment

and the utter defeat of man's strength by those forces broken loose a moment later forms a scene eminently lending itself to dramatic description.

Fortunately, however, signs are at length visible that the public are becoming aware that the question of railway safety, like most others, has two sides. One may venture now to say openly what could only be hinted a year or two back by anyone who valued his reputation for sanity, that railways may be made unnecessarily safe ; that Caithness and Cardigan do not need quite the same safety appliances as the main line of the North Western ; that, if I may use a simile I have already used elsewhere, the fact that Jarrah wood blocks laid on six inches of concrete are found the best and most suitable pavement for the Strand and Fleet-street does not necessarily prove that they are absolutely essential as paving for the High-street of Little Pedlington. A committee of twenty-five gentlemen, including in their number engineers of the highest eminence, an ex-President of the Board of Trade, and no less than ten members of Parliament, all of whom have constituents to whom they are responsible, has unanimously reported to a conference of upwards of fifty persons, most of them present in a representative capacity, which has equally unanimously accepted their report, as follows :—

"The Committee believe that the impediments to construction may be greatly diminished, and that on a large proportion of such lines as are contemplated by their enquiry, the regulations which have been enforced with a view to public safety may be considerably relaxed.

"In the case of lines of small traffic, having few trains in the day and working at a moderate speed, there is little risk compared with that occurring on great trunk lines having numerous sidings and branches, and carrying, at high and varying speeds, a complicated traffic of passengers, merchandise, minerals and cattle, at all hours of the day and night.

"It seems reasonable that details as to route, width of gauge, fencing, level crossings, bridges, gates, the use of public roads, stations and station requirements, signals, continuous brakes, and many similar matters—unnecessary expenditure on which, taken together, adds greatly to the cost—should differ in different parts of the country, depending in each case upon the nature of the country and the traffic to be conveyed."

Commenting on this report, the *Times* writes in a leading article :—"The reasoning is unanswerable—the wonder is that it should have to be employed." And yet there can be no doubt that it really was necessary. No longer ago than the year 1889 Parliament passed an Act known as the Railway Regulation Act, brought in, I may say, by the then President of the Board of Trade, who now signs the report from which I have just quoted ; and acting, as they believed, in conformity with that Act, and unquestionably acting with the full support of public opinion, the Board of Trade in the year 1890 made an order requiring in Caithness and Cardigan precisely the same perfection of safety appliances which were laid down for adoption on the main line of the North-Western. I well remember that at that time a gentleman who has since done good service on the Light Railway Committee, wrote to the *Times* in protest, and pointed out that, had the Board of Trade requirements existed in other and poorer countries, they must to this day have gone without railway communication altogether. A day or two after there appeared in one of the least sensational journals in the country—I mean the *Spectator*—an article holding this gentleman—who having been officially connected with railways in three continents had a better right to speak on the subject than most people—up to ridicule, and asserting the unalterable determination of the British public to have no railways at all unless it could have them in ideal perfection. Let us hope that we have broken away from these transcendental theories now. It will take us, however, some time before we can get away from their effects. For one thing, in the poorer parts of the country, they have left the public exposed to the appalling risks—I speak of course relatively—of travelling in their own carriages or even in carriers' carts ; for another thing the result has been in a very serious waste of money badly needed elsewhere. Let me give a specific instance. The Cambrian is a company with 232 miles of line in the thinly-peopled districts of central Wales, and the Cambrian has been called on to spend £200,000, or in round figures £860 per mile, in meeting the requirements made under the Railway Regulation Act of 1889. And let it not be supposed that the money has come from the superfluity of the shareholders. The company does not pay, and, as far as my knowledge goes, never has paid a dividend either on ordinary or preference stock. It can only meet its debenture interest with difficulty. The one source from which the £8,000 a year which the new safety appliances have cost—they have cost a great deal more if one were to allow for

maintenance and working expenditure as well —the one source from which this £8,000 a year can come is the pockets of the travellers along the line and of the farmers and fishermen who send the goods traffic. Nor let it be supposed that in fact all this expenditure has saved human life. It is true that fatal accidents have not happened since, but then they did not happen in the past. I believe I am correct in saying that for the 20 years previous to 1889 the Cambrian railway had not lost one life. Even without all these complicated paraphernalia of precaution there is, to quote once again the words of the Board of Trade Light Railways Committee report, "in the case of lines with small traffic, having few trains in the day and working at a moderate speed, little risk compared with that occurring on great trunk lines." If anyone will cast his memory back over the serious accidents of the last few years, he will remember that they practically all occurred on main lines of railway—at Llantrissant, on the main line of the Taff Vale; at Taunton, on the main line of the Great Western; at Northallerton and Thirsk, on the main line of the North-Eastern; at Chelford and Poulton, on the main lines of the North-Western. Does anyone suppose that the Railway Regulation Act of 1889 was needed to compel the North-Western and the Great Western and the North-Eastern to protect their immense and constant traffic with all possible safeguards? Is it not notorious that the Act was only intended and in practice only had the effect of bringing up the small lines to the standard attained long since on the highways of through traffic?

But, it will be said, "Why slay the slain? The President of the Board of Trade has pledged himself to bring in a Bill relaxing the elaborate and costly safety requirements in the case of light railways in poor districts. The ex-President of the Board of Trade has practically signified his readiness to support him. Why go back on what is now an old story?" I venture to do so for this simple reason: that I believe this battle is only just beginning. It is true that to anyone brought seriously face to face with the question, and making himself responsible for the answer that he gives to it, the absurdity of putting the Little Pedlington High-street in the same category with Fleet-street and the Strand is so patent that no word of further argument is required; but the bulk of the public have never been brought face to face with the facts, and are in no way responsible for the answer that they make to them. Unless public opinion can be much more thoroughly educated on this matter that there is any sign of its being at the present moment, those who have advocated throughout the removal of restrictions will see themselves deprived in detail of all the concessions which they have fought for and acquired in general. The new railways which are to be constructed may not have to face the demands made heretofore by the Board of Trade, acting under the authority of Parliament, but they will have to run the gauntlet of public opinion in their own locality, and each county council, and town council, and land-owner, and frontager, and road surveyor, and highway board, while perfectly ready to admit in the abstract that railways can exist without signals or station buildings, without fences and level-crossing gates; that they can run down the middle of the street and draw up in the market place opposite the gates of the town-hall—as they do with the full approval of the population in every other country in Europe—will, when it comes to the concrete case of the particular line with which they are alone concerned, press for all the elaboration, all the precautions, and all the expenditure to which we have hitherto been accustomed in this country.

I cannot attempt here to go through all the various points in which light railways, if they are to come into existence at all, must differ from existing lines. Let me take one or two specific instances. Take the case of level crossings. The existing law says that, unless under exceptional circumstances, a railway shall only cross a road by a bridge under or over; in exceptional circumstances, crossing may be permitted on the level. In that case, however, gates of an elaborate and expensive character must be provided, and a watchman must be resident on the spot to open and close them. Few people probably realise what this means. There was a tale the other day in the railway papers *apropos* of the United States—a country where, of course, overbridges and gates at crossings are things practically unknown—of a railway company which applied to a great lawyer to draft for them a notice which should arrest attention and cause people to be careful in crossing the rails. His notice, when drafted, was in this form: "Stop! Look! Listen!" and the railway company—so the tale went—paid him $10,000 for this draft. For that sum, however, they protected, according to American standard, all the crossings on their railway. The same money in England would suffice, so I am informed by

an eminent engineer of great experience, on the average, to build one bridge over or under the line. Under ordinary circumstances, he further said, it was not worth while to apply for special statutory permission to make a level crossing, because the £2,000 of capital required for the bridge meant only some £70 per annum of interest, and it cost as much as this to maintain the gates and the gatekeeper's house and to pay his wages. Yet though it costs as much to make a bridge as would build half a mile of light railway in most countries, if public opinion, as evidenced by the newspapers, had its way, our railway companies would be required to put bridges not only at every highway crossing, but actually at every crossing of an occupation road or a footpath. I read a short time back, *apropos* of a distressing accident near Canterbury, where a man was so incredibly foolish as to drive a waggon full of hop-pickers through a farm gate on to a railway in a fog, without waiting till the gate on the further side could be unlocked, that hecatombs of victims were sacrificed to railway level crossings. This set me to look up statistics, and I found that whereas, during the year 1893 there were 140 persons killed and 5,330 persons injured by being run over in the streets of London, in the same year there were only 55 persons killed and 30 injured at all the level crossings in the United Kingdom. Within the last few days, I have read in the Report of the London Fire Brigade, that in the year 1894 there were 82 deaths from fire in London; 32 of these were caused by paraffin lamps upsetting or exploding. Now, a paraffin lamp that, if upset, causes no danger whatever, either of fire or explosion, can be bought for a few shillings. Would it not be better to protect the hecatombs of victims of street accidents and inferior paraffin lamps in London first, before we undertake the much larger business of abolishing level crossings throughout the United Kingdom?

But let us assume that the statutory regulations as to level crossings will be modified by Parliament in consequence of the Light Railway Committee. We may also assume, no doubt, that the Board of Trade will act loyally in the sense of that report and modify as far as possible its own non-statutory requirements on matters such as signalling and interlocking, station buildings, block working, and so forth. We shall still be as far as ever from making light railways possible, unless we can induce the local authorities and the population, whom they quite faithfully represent, to execute a complete *volte face* on matters more especially within their jurisdiction. It may be a question, for instance, in any individual case, so far as the open country is concerned, whether a light railway ought to be built as a tramroad, running, that is, along the public road or as a railway proper, occupying, that is, land specially purchased for the purpose. But when the railway gets near the town there is no question whatever: it must either stop in the outskirts of the town, and so at once fail as a commercial undertaking, and fail to afford half the benefit which it ought to afford to the population of the district, or else it must come into the heart of the town along the public street. The idea of its purchasing and pulling down houses, in order to make a special right of way for itself, is absolutely out of the question. Now, at present, steam trams do in a very few instances run into English towns, but they are hampered by restrictions so excessive as to be, in most cases, prohibitory. On the Continent, for instance, the engine puffs into the market-place with eight vehicles behind it; the English rule restricts it to a single car. Or, again, the English rule provides for 9 ft. 6 in. space between the tram-lines and the kerbstone, and lays down that the tram-car shall not overhang the wheels more than 11 inches. The Italian rules, and the Belgian rules are very similar, say nothing about overhang, but provide that the rails shall not come within 2 ft. 7 in. of the buildings; in other words, the tram-car itself may approach within, literally, a few inches of a man's front door, whereas in England it must be kept about 8 ft. 4 in. clear of the edge of the footpath. Now, unless English local authorities are prepared to take up something like the Italian and Belgian position, they will not get light railways; for it is not possible, nor indeed desirable, that the Board of Trade should compel the local population—who, after all, are the people mainly concerned—to forego their own objections on matters such as these. Another point, concerning, perhaps, more especially rural authorities, is the question of speed. In England, a tram-car along the roads is limited to 8 miles an hour as a maximum, which means practically about 6, when allowance is made for stoppages. In other words, an old woman going to market in a cart, with a smart donkey, can go as fast as the tram-car. In Belgium, the maximum speed is 18 miles an hour, and the inclusive speed somewhat between 12 and 14; or, in

other words, a thoroughbred horse in a dog-cart can only keep up with it for short distances. Now, if these new light lines are to be restricted to any speed at all approaching 6 miles an hour, it is certain that they will never develop any serious passenger traffic; and unless they do, it is certain, in the first place, that they will not perform what is perhaps the most important task that they can possibly undertake, namely, putting an end to the existing isolation of country districts; and, in the second place, they will never from goods alone earn a sufficient revenue to make them profitable undertakings. I should like, in this connection, to call attention to an article by Richard Jefferies published in "Field and Hedgerow," which contains the last essays he ever wrote. It is called "Steam on Country Roads." No one, I think, will suspect Richard Jefferies either of being exceptionally in sympathy with commercial ideas, or exceptionally in love with railways; nor will it be denied that he knew the country and country life; and this is what he wrote. (I ought, perhaps, to say that his idea was that trains would be drawn by light traction engines running on the road without rails. This, however, is an engineering point on which one perhaps is justified in treating his opinion as of no special importance.)

"Two through passenger road trains a day, one in each direction, carrying light parcels as well, and traversing (say) 40 or 50 miles or less, would probably soon obtain sufficient support, as they ran from village to village and market town to market town. At present, those who live in villages are practically denied locomotion unless they are well enough off to keep a horse and trap and a man to look after them. A person residing in a village must either remain in the village, or walk, or go by carrier. The carrier stops at every inn, and takes a day to get over ten miles. The exposure in the carrier's cart has been the cause of serious illness to many and many a poor woman obliged to travel by it, and sit in the wind and rain for hours and hours together. Unless they ride in this vehicle, or tramp on foot, the villagers are simply shut off from the world. They have neither omnibus, tramway, nor train. Those who have not lived in a village have no idea of the isolation possible even in this nineteenth century, and with the telegraph brought to the local post-office, the swift message of the electric wire, and the slow transit of the material person — the speed of the written thought, and the slowness of the bodily presence—are in strange contrast.

"When people do not move about freely, commerce is practically at a standstill; but if two passenger road trains, travelling at an average speed of not more than eight miles an hour, one going up and the other down, and connecting two or more market towns and lines of railway, passed through the village, how different would be the state of things! Ease of transit multiplies business, and, besides passengers, a large amount of light material could thus be conveyed. There would be depôts at the central places, but such trains could stop to pick up travellers at any gate, door, or stile. If the route did not go through every hamlet, it would pass near enough to enable persons to walk to it and join the carriages. No one objects to walk one mile if he can afterwards ride the other ten. Besides these through trains, special trains could run on occasions when numbers of people wanted to go to one spot, such as sheep or cattle fairs and great markets. Large tracts of country look to one town as their central place, not by any means always the nearest market town; to such places, for instance, as Gloucester and Reading, thousands resort in the course of the year from hamlets at a considerable distance. Such road trains as have been described would naturally converge on provincial towns of this kind, and bring them thrice their present trade. Country people only want facilities to travel exactly like city people. It is, indeed, quite possible that when villages thus become accessible many moderately well-to-do people will choose them for their residence, in preference to large towns, for health and cheapness. If any number of such persons took up their residence in villages the advantage to farmers would, of course, be that they would have good customers for all minor produce at their doors. It is not to much to say that three parts of England are quite as much in need of opening up as the backwoods of America. When a new railroad track is pushed over prairie and through primeval woods, settlements spring up beside it. When road trains run through remote hamlets those remote hamlets will awake to a new life."

Now I am quite sure that most English people, when they hear a suggestion that trains should be allowed to run at quite considerable speed across or even along turnpike roads, and to puff into the middle of the market-place on a market day, and draw up in front of the town-hall among all the farmers' carts and the market women's baskets, will merely smile and say that though, of course, such things may be possible for mere Belgians and Italians, no one in his sober senses could propose to introduce anything of the kind in England. The odd thing is that something of the very same kind is going on at this present moment all over England, and has been any time this last fifty years, only it has been done without legal authority, Let me give one or two instances. Our Chairman of this evening mentioned the other day three cases of what

are known as "overland routes"—light railways, that is, laid down for the conveyance of materials for some great engineering work—at present in operation in England. Two out of three cost well under £1,000 a mile; a third, seven miles in length, actually cost only £584 per mile. On one of these lines I am told—I will not mention its location more particularly as, of course, the whole thing is quite illegal—the contractor is carrying at this moment a quite considerable passenger traffic, sufficient indeed to return by itself a reasonable income on the cost of the line. Take another instance, mentioned at the Board of Trade Conference, on December 6th—the China Clay Tramways, in the neighbourhood of Poole Harbour. These tramways are 2 ft. 8 in. gauge, and have a length of 3¼ miles. The trains run all day, and their speed 12 to 15 miles an hour. The line is unfenced, and has five crossings over the public roads. It has been worked for 50 years; in that half century the lists of accidents is as follows:—One cow killed during the making of the line; one woman committed suicide; one donkey killed through the fault of a brakesman; and a cart and horse incapacitated because the horse shied to avoid a collision. On turning to the other end of the country, if any one will buy an Airey's railway map of the Durham and Northumberland district he will find the face of those two counties scored in all directions with private railway lines; there must in all be many hundreds of miles of lines. But they are not public railways, and consequently the Board of Trade know nothing of them. Yet they carry thousands upon thousands of passengers, cross and run along roads in all directions, and I have never heard that any accident took place worth mentioning. Not but what there is certainly every chance for them. One Saturday afternoon last summer I met apparently the whole population of a colliery village, men, women and children, travelling by one of these trains. The train was full, and most of the men seemed to be riding either on the roofs, or the steps, or the buffers of the carriages. Alongside this picture let me put a companion one. There is a similar line in Cornwall from the Wenford Bridge Quarries down to Bodmin. Unfortunately for the public convenience it belongs to a great railway company, and great railway companies occupy a responsible position. Consequently when the Wenford Bridge quarrymen who live in Bodmin, four or five miles off, wish to be allowed to ride down by train, the general manager feels himself compelled to reply that he cannot carry passengers except on a line brought up to Board of Trade standard; that to do this would imply a capital expenditure so large that the quarrymen's fares could never avail to pay interest on it; and that therefore he must regretfully leave them to trudge backwards and forwards to their work.

But I must leave this point. My excuse for dwelling on it at such length must be that no legislation, no Board of Trade action, no benevolent treatment by great railway companies, can bring light railways into existence as long as public opinion maintains its present attitude in reference to methods of construction and working in which safety is—erroneously as I think—believed to be involved. Let me turn to another though not unrelated point. I mean, the hours of labour on these lines. In a note appended to the report of the Board of Trade Committee, Mr. Channing, M.P., states:—"In any legislation as to light railways, tramways, or tramroads, I think the employees ought to be included in express terms among the railway servants to whom the Hours of Labour (Railway Servants) Act, 1894, applies, unless they are already so included." Now that they will be included on any new light railway goes without saying. Let us see, however, what the Act provides. Leaving out machinery, the Act practically says that the railway company shall so arrange the work of its out-door staff "as will in the opinion of the Board of Trade bring the actual hours of work within reasonable limits, regard being had to all the circumstances of the traffic and to the nature of the work." Now comes the question what these last words mean. The Board of Trade interpretation will depend, as it ought to depend, on the view taken by Parliament and the public. If Parliament and the public choose to regard these new railways as ordinary railways, they will expect eleven hours, or twelve at the outside, to be the limit of a day's work. If they expect that, I venture to say that in many instances they will have to go without a possible light railway altogether. Imagine a light line, say eight miles long. The wages of a driver and fireman come to 50s. per week, or, in other words, 4s. per mile per week. To employ a second driver and fireman means adding at one stroke six or seven per cent. to the working expenditure of the line. That may often mean bridging the gap between success and failure. On the other hand, a farmers' line must start its first train not later, probably, than six o'clock in

the morning. To avoid giving the driver and fireman more than twelve hours work, the last train must then be back at the terminus at five in the evening. Does anybody suppose that a line so worked can give a satisfactory service to its district? Supposing, on the other hand, public opinion to realise that the engine-driver on one of these lines has really no more in common with the driver of a main line express than a farmer's lad in a hay cart has in common with the driver of the London and Brighton coach, it will be possible to organise a reasonable service which, with its first train at six in the morning and its last at eight or nine in the evening, and long interval of rest for the men between, can give all the service that a country district should reasonably require.

Another point on which I fear I shall show myself yet more out of touch with public opinion—the question of the rates and fares which these companies will need to charge. It is, I believe, an axiom in agricutlural circles that the existing railway rates are extortionate, more especially for agricultural produce. One main argument often adduced in favour of light railways is that they will, partly from their superior philanthropy, partly from the fact that they will be constructed cheaply, charge rates much below those at present in force. The Central and Associated Chambers of Agriculture, meeting in this very room only a week ago, resolved unanimously that light railways were desirable "provided protection be given against unreasonable or unfair charges, and conditions be made for the conveyance of agricultural produce upon them." The companion resolution makes it clear that in the view of the Chambers of Agriculture, "unreasonable and unfair charges" is only another way of saying "charges made by the existing railways." Now, for my own part I believe—I speak in all seriousness—that for retail local distributive traffic, our present railway rates are among the lowest, if not the lowest, in the world. The point is, of course, one on which, in the present deplorable condition of our railway statistics, no precise information is attainable. But I have myself on one or two occasions attempted to compare rates for similar traffic under similar circumstances in this country and in the United States, where, on the whole, the rates are admittedly the lowest in the world, and I have not in any case found that the English companies come badly out of the comparison. I had occasion within the last few months to discuss the matter somewhat fully with a gentleman sent over here by the Prussian State railway authorities, to investigate our arrangements. He told me that one main impression he took back from the study of our lines was that the German rates for local distributive traffic were excessive and ought to be reduced. Be that as it may, on this point at least there can be no doubt whatever. The rates on new English light railways will need to be, on the average, higher and not lower than the rates on existing railways. Otherwise the lines cannot pay at all and will not be made. The proof of this fact is, I think, very simple. In the first place, let me give the French experience. According to the French statistics of a year or two back—I have not later figures by me, but so far as the circumstances have changed in the interval, it has been in the direction of lower average charges, especially for passengers on the main lines—the average charge made for passengers per kilometre on the lines of the great companies was 4·63 centimes, on the light railways 5·37 centimes. In the case of goods the difference was vastly greater, the average rate per ton being 5.95 centimes on the ordinary lines, and 10·99, or not far from double, on the light railways. I have left the figures throughout in their French form, as the ratio between them and not their absolute quantum is the only point of interest to us for our present purpose. We cannot compare the average ton-mile rate in England with the average ton-mile rate in France, for the simple reason that ton-mile statistics are unfortunately not kept in England. If, however, we did know what the average ton-mile rate on the great lines was, I think we might safely assume that it will be at least half as much again on the projected light railways. Meanwhile, in the absence of statistics, we must deal with the question from another point of view.

There was a somewhat amusing instance of the impossibility of forcing small companies in poor districts to content themselves with the rates which suffice for main lines when the new Railway Rates Acts were before the Joint Committee of the two Houses of Parliament in the Session of 1892. The Board of Trade—and of course I am not blaming the Board of Trade, it was merely acting in an executive capacity to carry out what was believed to be the intention of a more than ordinarily obscure Act of Parliament—had lumped together in the same schedule, giving them maximum

powers of charge only slightly higher than those of the great systems of the country, ten poor little starveling companies. Of the whole ten, not one paid a penny of dividend to its ordinary shareholders; one alone paid a small dividend on its preference stocks; six paid their debenture interest in whole or in part—most in part; in the case of the remaining three, the earnings were insufficient to cover even working expenses. With a single exception these poor little companies submitted like sheep to the Board of Trade shears. One alone amongst them, the Liskeard and Caradon, which has the advantage of having as manager a Receiver appointed by the Court of Chancery, ventured to appear before the Joint Committee to oppose the Board of Trade draft schedule, and this was the tale that its counsel told. The goods traffic of the line was almost entirely in granite brought down from the Cheesewring quarries. For that traffic they were charging at present 3d. per ton per mile. Even at this rate, the line was doing little more than pay working expenses. If the maximum rate was reduced, as proposed by the Board of Trade, to $1\frac{1}{2}$d. the Receiver had decided simply to shut up the line entirely. Nor was this all; for counsel produced the evidence of all the leading traders on the line, imploring that the company might be permitted to continue to charge them double what the Board of Trade considered reasonable, rather than that the line should be closed, and they should be forced either to cart at 6d. or, more probably, to cease working their quarries altogether. The position was so obviously and comically indefensible that the Committee abandoned it without any attempt at defence, and the Liskeard and Caradon obtained statutory authority to continue its threepenny rate for granite. The other nine companies, however, will find it presumably to all time impossible to make both ends meet on their charges, which are restricted to $1\frac{1}{2}$d. Nor is this all; for the Liskeard and Caradon only asked for amendment of its statutory schedule in the one particular, and accordingly, the rates for traffic in all other classes remain as originally proposed by the Board of Trade. With this very remarkable result that, if the quarrymen, instead of sending their granite wholly undressed, were to trim it into kerb-stones or pitching at the quarry, so making it more valuable, it would, according to the statutory classification, go up one class higher, into Class B; but for this the maximum rate legally exigible is only 1·60d. Nor is even this all. Ordinary articles of commerce, ten and twenty and fifty-fold more valuable per ton than granite, are by no means permitted to pay the granite rates. Flour and meal and cattle cake, iron and steel wares and timber are only permitted to pay 1·80d. Fruit, hay, and straw may only be charged 2·20d. Oranges and lemons, pickles, raisins, starch, and so on, only 2·65d. It is only when we come to articles of really high value, such as draperies and groceries and small hardware that we reach a charge of 3·10d. per ton per mile—fractionally above that allowed for undressed granite.

Now let us approach this question from another point of view, and see the reason why cheap lines must charge dear. Let us take two pairs of lines, one of each pair having a large capital per mile and a heavy traffic, the other being a cheap line, but in a poor district with light traffic; and let us compare them together. The Barry Railway in South Wales, 29 miles long, has a capital of £2,658,734; the Pembroke and Tenby, on the other side of Swansea Bay, has identically the same mileage, but the capital is only £447,263, or about one-sixth. Consequently, to pay 5 per cent. on its capital, Barry needs to earn £132,936; the Pembroke and Tenby only £22,363—roughly, once more one-sixth. But Barry carries 5,650,000 units of traffic—reckoning, as is usual in such cases, a passenger as equivalent to a ton of goods—the Pembroke and Tenby only carries 400,000, or one-fourteenth of the amount. Consequently, the charge for capital against each unit of traffic, which for the Barry Company is only 5·8d., is, in the case of the Pembroke and Tenby, 13·3d. Now, let us come to working expenses. On maintenance of road, Barry spends £13,500, the Pembroke and Tenby only £2,705; but per unit of traffic maintenance costs Barry ·57d., while it costs the Pembroke and Tenby 1·62d. So, too, on locomotive expenses, and repairs, and renewals of rolling stock, Barry spends £25,700, and the Pembroke and Tenby £5,700; but per unit of traffic this means 3·4d. to the Pembroke and Tenby, and only 1·1d. to the Barry Company. Similarly traffic expenses cost the Barry £15,694, and the Pembroke and Tenby £2,876; per unit of traffic this means for the Barry ·6d., and for the Pembroke and Tenby, 1·23d. Yet once more, for general charges, the Barry spends £8,515, the Pembroke and Tenby, £1,856; in other words, general charges per unit of traffic cost the Barry only ·3d., and the Pem-

broke and Tenby 1·1d. Is it not sufficiently evident on these figures that, charges being anything the least like one another, either the Pembroke and Tenby will starve, or the Barry will pay a fabulous dividend? Such is, in fact, the case, for even though the actual rates charged are very much lower on the Barry than on its poorer rivals, the Barry Company pays 10 per cent. on its ordinary stock, while the Pembroke and Tenby can only meet a portion of its preference dividend. Now let us compare another couple of lines. The London Brighton and South Coast Company has 439 miles of line, and its capital amounts to £24,240,000; the Highland Company has 445 miles, a fractional difference, and its capital is £5,360,000, or little more than one-fifth. Consequently, to pay 5 per cent. on its entire capital, the Brighton Company needs £1,212,000; the Highland Company only £268,000. Practically, in round figures, for our present purpose, this is, we may say, what both companies do. But when it comes to earning their income, they go about it in a very different manner. The Brighton Company — even not including its season ticket traffic, the statistics of which are given in a form perfectly valueless for comparative purposes—carries 49,900,000 units of traffic; the Highland, 2,206,000. Consequently, the charge for capital against each unit of traffic on the Brighton is 5·9d., while on the Highland it is no less than 29·1d. So, too, with working expenses. Maintenance of the Brighton line costs £206,000, as against £51,000, or just a quarter, in the case of the Highland; but seeing that more than twenty times as many units of traffic pass over the Brighton per mile, its maintenance cost per unit is only 1d., while the maintenance cost of the Highland is 5·5d. Locomotive charges and rolling stock repairs cost £474,000 to the Brighton, equivalent to 2·2d. per unit; to the Highland they cost £98,000, but it is equivalent to 10·70d. per unit. Yet again, on traffic expenses the Brighton spends £355,000, the Highland only £64,000; but per unit, the large sum works out at 1·9d., the small sum at 6·9d. On general charges the Brighton spends £45,000; the Highland, £11,000; but per unit the Brighton charge is ·2d., the Highland charge 1·2d., or six times as much. I ought not, perhaps, to use these figures without entering a caution. In the case of the comparison between the Barry and the Pembroke and Tenby, the ratio of the figure is, as far as I know, a real one; for the bulk of the traffic of each company is probably carried the greater part of the length of the line. In the case, however, of the Highland and the Brighton, the comparison is in considerable measure vitiated by the fact that the Highland is a long trunk line with few branches, while the Brighton may be more accurately compared to a bush which is all branches and no main stem; and a vast mass of the traffic is concentrated round the roots of the system at the London termini. Consequently, the fact that the Brighton, for instance, spends per unit on locomotive expenses only one-fifth part of that spent by the Highland is due quite as much to the fact that the Brighton only carries its traffic a few miles, while the Highland carries its traffic a much longer distance, as it is to the fact that the Brighton traffic is dense and the Highland traffic scant. Still, I think, even making all possible deductions of this kind, the figures I have given are enough to prove what is, I may say, a practical conclusion, accepted as axiomatic among railway men—that it is not the cheap lines, but the dear lines that may be expected to have the lowest fares; for a dear line implies a district capable of supplying a large traffic, while a cheap line means a line in a district capable only of suplying small traffic; and 100 pennies will always amount to a larger sum than a score of twopences, while the working expenses for carrying the hundred units will be nothing the least like five times those for carrying the score.

I press this point at a length which may, I fear, become wearisome, because it is of absolutely first-class importance. I heard the matter discussed the other day, and it was pointed out—as I have endeavoured to do here—that small companies must be allowed great latitude in the matter of rates. A member of Parliament who was amongst those present remarked, I believe, with entire truth, that "there would be no chance of getting any such proposals through the House of Commons." Be it so. In that case we know precisely what we have to expect. There will be few light lines built at all, and none except those built by the great railway companies. As, however, presumably the object of members of Parliament is not to increase the power of control which the great railway companies even now possess over the districts which they serve, I will before leaving the matter venture to read a letter, written by a gentleman who holds, I believe, a unique position, that of honorary secretary and manager of what may practically

be called a light railway, the Easingwold line in Yorkshire. The letter, I may say, is apparently addressed to the London agent of the company, but I may leave it to tell its own tale :—

"Dear Sir,—I am in receipt of a communication from you to the effect that the Board of Trade decline to give us any other terms than the North-Eastern Railway Company's schedule of charges. I take it for granted that this is their ultimatum, but I think it extremely hard that our struggling little company should have been put to all the expense of scheduling after distinctly expressing their willingness to accept the N.E.R. Company's schedule to avoid an expenditure they were not prepared to meet. If this policy of the Board of Trade is to be the rule, all I can say is, it is one greatly against the public interest generally and against the agricultural interests particularly. It cannot be in the public interest that big railway companies should have every help given them to become greater monopolists, nor that private enterprise in the construction of small agricultural lines should be thus discouraged. It is absurd to suppose that small railway companies can exist if they are only conceded the same terms as large companies. One of the greatest necessities of agriculture is these small lines, and one of the most effectual means of strangling them is the method now apparently adopted by the Board of Trade of harassing existing ones by heavy expenditure for no earthly good, and administering a timely warning to future ones, that exceptional circumstances and wants are no grounds for their expecting exceptional treatment.

"It comes to this—the big companies (as in our own case) will not either make such lines, or give anything but opposition to their being made, and private enterprise cannot because 'the law is the same for the rich big companies as it is for the poor small ones,' and a most ridiculous law it is. It should hardly require a politician to appreciate the vast importance of encouraging small lines in the interest of agriculture, nor a Q.C. to point out that in the matter of their construction, Parliament and the Board of Trade block the way instead of clearing it.

"I am not concerned to defend high railway rates; my point being that it is bad policy to treat a small line in the matter of rate the same as a large one, and that it tends to check the making of such lines.

"We will assume that private enterprise would, if encouraged, make a number of such lines, and that an agricultural population could thus put themselves in communication with the centres of trade, and diminish the cost of mineral and goods cartage by one-third provided an exceptional rate were allowed them. Oh! no, say the Board of Trade, if you cannot make a line to pay a moderate dividend by levying exactly the same rates as a big company some 100 miles or more levies, you must stop out in the cold, and your projected economies are out of the question.

"I have sent a copy of this to the President of the Board of Trade, and the member for our Division, and I hope he may see his way to enter a protest against the present line of policy.

"Will you please show this to the Board of Trade in your final dealing with them."

What course the Member of Parliament for the Easingwold division of the West Riding took in this matter I cannot say. Certainly he did not cause the Easingwold maximum to be raised. For in that case the shareholders had spent their money, and could not take it back after the line was made. But as far as new lines not yet made are concerned, it is a little difficult for one who is not a member of Parliament to understand how a farmer benefits by being protected against the possibility of railway rates of 3d. a mile if the only alternative be that he is shut up to carrying the produce in his own carts at a cost which can certainly not be reckoned at less than 5d. per mile.

I have dwelt at great—I hope not excessive—length on the necessity for the maximum of freedom to these small railways—freedom from restrictions, whether imposed by statute, by the executive action of the Board of Trade or of local authorities, or merely by public opinion, on technical methods of construction and working; freedom in the regulation of the hours of labour; freedom in the fixing of rates and fares; because it is only on condition of such a freedom that small lines can ever hope to come into existence at all, unless, indeed, the small line be merely an extension of an existing company, which, raising the capital on the easiest possible terms, obtaining skilled engineering and legal advice cost free, buying its materials wholesale and in the best markets, and being enabled to regard the new line as a feeder to its existing system, can afford to build under terms and conditions which, to a small independent company, would mean sheer starvation. Now it will, I think, be generally agreed that, as a rule, the great company occupying the district is the natural person to look to for the building of any new lines that are needed. For all that, it is most undesirable that the conditions should be such that the construction of light lines is possible only either by the direct action or with the support and encouragement of the great companies. On all grounds, and not least on those of what may be called statesmanship, it would be most unfortunate that a whole district should appear to be absolutely at the mercy of a private trading company. Further, to ex-

pect that no great company would abuse its position and would regard as *corvéable à discretion* lines so absolutely at its mercy, would be to expect the impossible. Yet, further, there are two very good reasons why, if the matter were left solely in the hands of the great companies, we could not expect an adequate development of light railways to take place. The first of these reasons is sheer lack of attention. Railway managers are a very hard-worked race. The wholesale traffic of their main lines is of vital importance, and the butter and egg traffic of Little Pedlington, developed to its utmost possible extent, can only be of infinitesimal importance by comparison. We cannot in reason expect that the general manager of a great company will spare much time and trouble for considering the possibilities of the Little Pedlington branch, and for negotiating with its inhabitants and smoothing away the obstacles caused by their possibly somewhat exaggerated apprehensions. Another reason is even more respectable. Let me give it in the shape of a specific instance. At the Light Railway Conference, the other day, Lord Edmund Fitzmaurice mentioned that he had in his hand a memorial, "very influentially signed locally, in favour of making a light railway some way or another, though the petitioners are rather vague at this moment as to who is to make it and how it ought to be made, to connect Frome with Gillingham on the main line of the South-Western Railway." Now, it may be highly desirable that this line should be made; on that point there is no need to express an opinion here. But to expect the Great Western to make it, and thereby hand over to the South-Western a large slice of the traffic of a district at present exclusively served by the Great Western, is to expect the Great Western Board to act diametrically contrary to their duty as trustees for the Great Western shareholders. On the other hand, it is equally absurd to expect the South-Western to make such a line. There are more impossible things than that the South-Western Company should make an onslaught on Great Western territory, but if so, the campaign will be opened on a large scale with an attack on the Great Western main positions at Bristol and in South Wales, and not with a petty local move against Frome and its cheese fair traffic. For the South-Western Company to vex the Great Western with a mere gadfly line like this, and so afford the Great Western a pretext for promoting new main lines into places like Bournemouth, Southampton, and Portsmouth, would be the act not of a body of business men, but rather of petulant children. Is it not then evident that room must be left for light lines in some cases at least to be constructed by new and independent companies?

This brings me, however, to a further point. Such lines must obviously in most instances effect junctions with the lines of existing companies. Now the law on this subject is at present contained in the Railway Clauses Consolidation Act of 1863. The gist of it may be said to be that a junction is to be regarded as a privilege conferred on the new company, and an obligation—and an onerous obligation—imposed on the old company. Accordingly, with perfect justice from this point of view, the law provides that the junction shall be made wholly at the expense of the new company, and that every expense, whether of construction, of maintenance, or of working, shall be borne solely by the new company. Now these provisions were absolutely right and proper in the days when new lines were merely competitive. Take, for example, the Frome and Gillingham line, of which mention has just been made. The junction of such a line with the Great Western at Frome would be a distinct injury to the Great Western Company, for its natural tendency would be to divert from that company's route existing traffic. It would be only fair that the new company, if in the public interest it obtained its junction, should pay to the uttermost farthing the expenses thereby caused. But the bulk of the new lines which are now likely to be made will be in no sense competitive—will rather be of the nature of feeders to existing lines. That they should be heavily fined for the privilege of contributing handsomely to the great companies' revenue is somewhat less than justice. This is certainly a matter which will need attention in any new legislation that is attempted on the subject. To show how serious the junction charges may be, let me give one concrete instance. I do not mention names, as there is no need to pillory the great company concerned, more especially as latterly it has shown signs of a readiness to adopt a more liberal policy. I find that for a junction between a great company and a small one, which is only used for one hour in the day and solely for goods traffic, the small company is called upon to pay a sum of £330 per annum —an amount which exceeds by more than £60 a year the whole receipts of the small company

from the goods exchanged there. Now let me point out how unfair in most cases it is to throw any such charge on the small company. Mr. Pain, the managing director of the Southwold line, which is practically, though not technically, a light railway, has publicly stated that the traffic passing between his own company and the Great Eastern through Halsworth Junction was worth, in 1893, £3,600 to the Southwold, and £12,000 to the Great Eastern Company. In this particular instance the bulk of the traffic so exchanged is absolutely new, and never came on to the Great Eastern at all till the Southwold line was built. But assuming that in ordinary cases half, or even three-fourths, of the traffic passing through the junction reached the main line before the new branch was made, we still have a very large new traffic contributed to the main line company—traffic, moreover, which, as it is carried in existing trains, can be worked for almost nothing. In other words, the construction of a new branch joining an old line, provided it joins that line only and is not part of a new competitive scheme, is a very great benefit to the old line, and for that benefit it is only reasonable that the old line should pay. And the payment should not merely be, as it usually is in foreign countries, in the shape of constructing the junction for the new line gratis or almost gratis; there is no reason why the old line should not largely aid the finances of the new company by guaranteeing to hand over a fixed per-centage of the money earned for the carriage on the old line of traffic passing to or from the new. That many companies in this country would be ready to guarantee such traffic rebates, as they are commonly called, I have no doubt whatever. For my own part, I should be prepared to say that it would be nothing more than justice if companies which refused to give such rebates voluntarily were constrained to do so by a little Parliamentary compulsion.

But this paper has already exceeded the limits within which it ought to have been confined, and I must hasten to a conclusion. Before, however, finally arriving there, let me say a word or two more. In the first place, I have omitted, deliberately—and in any discussion which may follow the reading of this paper I would venture to suggest that it might, with advantage, be omitted also—the discussion of two questions: the question of gauge and the question whether the light lines of the future are to be laid along the roads or on separate and private land. On both these questions regarded in general a great deal can be said on either side. But though one man may approach the question of gauge or the question of tramway *versus* railway, with a prepossession towards one solution rather than the other, it cannot, I think, reasonably be denied that in any individual case the matter must be decided on its own merits. The strongest prepossession in favour of tram lines must, for example, yield to the fact that in a particular concrete case the only road available is a Devonshire lane; or, again, the strongest prepossession in favour of normal gauge lines must give way to the concrete fact that in a particular instance capitalists, misguided perhaps, are prepared to construct a 2-foot gauge line, while for a normal gauge line no one is ready to find the money.

There is another question I have deliberately avoided—the question of subsidy or guarantee by State or local authority. On that question, when it comes within the range of practical politics, there will be much to be said of great interest. On the one side, for example, that without public assistance no country in Europe except, to some extent, Holland, has managed to obtain a satisfactory development of light lines; that, on the other hand, States that have tried the guarantee system have burnt their fingers badly; and that in France, just as much as in Ireland, lines have been constructed under the guarantee system which, while laying a grievous burden on the local population *qua* guarantors, have yielded them but little benefit *qua* producers and consumers, but which, even though not carrying traffic sufficient to pay more than half the actual working expenses, have yielded and continue to yield a handsome income to the astute promoter; that, moreover, for us the problem is further and very seriously complicated by the fact that railway competition is in England almost ubiquitous. It is one thing to guarantee, as in France or Ireland, the construction of a feeder to a system with a complete monopoly of its district; it is quite another to guarantee a line introducing new competition such as the Frome and Gillingham, of which I have already spoken. And if we are not very careful we may find—as has been found, for example, in the matter of building workmen's dwellings in London—that each investment of £10 of public money has frightened out of the business many times that amount of private capital. But, as I have said, the discussion

of this point is just now premature. Whatever may happen later on, it is quite certain that at the present moment neither the State nor the local authorities are prepared to find money in any shape or form for the construction of light railways in this country. Another matter that one might have been tempted to deal with is the question of the legal machinery provided for sanctioning the compulsory taking of land, and what is, I believe, much more important though it is not commonly so regarded, the law regulating the compensation to be paid for land so compulsorily acquired. But I understand that Mr. Pain, a gentleman eminently qualified to express an opinion on these points, is to read a paper next week before the society, of all others best capable of discussing it—I mean the Surveyors' Institute—and accordingly I refrain from raising it here.

Let me conclude by giving one instance—fairly typical, as I believe, of the quite important places in this country, commonly supposed to be thoroughly well provided with railways, which are still left in almost mediæval isolation. Tollesbury, in Essex, lies on the Blackwater, within 40 miles of London; it has a population of about 1,700, and its nearest station is Kelvedon, 10 miles away. The place has possibilities of development in all sorts of directions. The Blackwater is a paradise for the small yachtsman and the sportsman, who is prepared to rough it in the pursuit of wild fowl. There is already a valuable oyster fishery and a fleet of 80 smacks. On shore there are seed farms and fruit farms, which absorb fish manure and London street refuse by the thousands of tons. At present, of course, the passenger traffic is almost non-existent, the perishable traffic but scant; while the heavy traffic goes entirely by sea. Were a light railway made, however, that which has happened elsewhere—at Southwold, for instance, some 50 miles further along the same coast—would happen here too. The passenger traffic would increase by leaps and bounds; the fruit and seed farms, the fish and osyter trade would make a spring forward; while the heavy traffic in coal and manure would be diverted gradually to the Great Eastern Railway. That the directors and general manager of this very enlightened company are even better aware of these facts than I am I make no doubt whatever. Why, then, have they not built the line already in spite of all the insistance of the local population? For the simple reason that all the traffic of Tollesbury could never pay interest on a line built to present Board of Trade standard at a capital cost of £10,000 per mile. But once we have a new light line standard, once it is made possible in this country, as it always has been in every other country, to build local lines in a manner suitable for local traffic, at an expenditure of probably not more than the half of £10,000 per mile, Tollesbury will, I imagine, have no difficulty in persuading the Great Eastern Board to reverse their decision, and Tollesbury—which I mention simply because my attention having been accidentally called to the place, a local gentleman has been kind enough to give me precise and detailed figures—will get its railway.

This I am persuaded is the true line to follow in the light railway question at the present moment. Let us remove the restrictions, technical and commercial, which at present fetter light railway development, let us give the capital at present overflowing the bank tills not only in London but in every financial centre in the United Kingdom, and at present being, one might almost say, jettisoned into colonial gold mines for sheer lack of suitable investments at home, a chance of employment on reasonable terms, and then we shall see how much or how little private enterprise is able to do for us in this matter. If it fails, then will be time enough to talk about State subsidies or county council guarantees; but private enterprise has never failed us yet where it has been given a fair field and no favour, and for my own part I cannot believe that it will fail now to secure for us all the railway development that we can reasonably demand.

DISCUSSION.

The CHAIRMAN, in inviting remarks on the paper, said that there were certain points, as indicated by Mr. Acworth, which it would be well not to discuss. He hoped that the word "gauge" would not be mentioned, and that the subject of these railways passing along public or private roads would also be avoided.

Mr. F. W. WEBB said, in reference to the safety of these lines in crowded places, he could speak of almost five miles of railway of this description. Some 8,000 people were employed at the works at Crewe, and crossings existed in all directions; but during 13 years no accident to life or limb had occurred from the introduction of the lines. He might refer to a light railway within his knowledge on which both passenger and goods traffic was carried—as in many other places—in this case the line ran along the road

for a great part of the distance. That line was working very successfully, and was carrying a large amount of traffic. Originally it was worked by horses, but engines were now employed, drawing as much as 90 tons in a train. A large traffic had been developed by the line, and its introduction had been of great benefit to the inhabitants of the locality. The same result would no doubt follow the construction of these lines in other places.

Mr. A. C. PAIN entirely agreed with the views expressed in the paper. Referring to the report of the Board of Trade Committee, he disagreed with their recommendation that regard should be had to local responsibilities, and that powers granted by Parliament should be exercised under local control. If county councils were to be empowered to authorise light railways, the whole thing would become a dead letter. County councils could not decide with absolute impartiality in purely local questions. However honest and upright they were, local influences would come in, and they would refuse to grant necessary powers unless they could get a *quid pro quo*. They would not take bribes in money, but as in the case of tramways, in paving or something else that ought to be done by themselves. If a light railway was projected to a corporate town, and county coun cils had to be consulted, the matter would have to be fought two or three times over. Such conditions would be absolutely prohibitory, and in most cases Parliament would have to be applied to to obtain the necessary authority. The remedy lay not in giving power to the County Councils, but in altering the Parliamentary procedure, with its costly fees, advertisements, and plans. There was no need for Committees of Lords aud Commons. Why should not a Joint Committee of both Houses be constituted to deal with the matter? These lines would, for the most part, be very short, and there was no necessity for following the Parliamentary procedure adopted forty or fifty years ago for the great trunk lines traversing the kingdom. Another fundamental error in the report of the Committee was that in all cases the consent of a majority of owners of frontages should be required. He would not ask the assent of a single owner. The Southwold Railway was opposed by most of the landowners in the locality, but for fifteen years it had been a great boon to all classes. Had the consent of the majority of the landowners been necessary that line would never have been made. It was carrying from 80,000 to 100,000 passengers every year, and no loss of life had occurred. One man only had been injured, trying to get into a carriage in motion, and now the Board of Trade had required them to put on continuous brakes without rhyme or reason, because, forsooth, it was in the Act of Parliament. As the line happened to be called a railway they had to incur that expense. The Board of Trade inspectors admitted that they only enforced these expensive requirements because they were obliged to carry out the law. A large discretionary power ought to be left to the Board of Trade in these matters, and when the passenger traffic had developed they could re-inspect and make requirements with regard to accommodation. Another point in the report was the prior subscription of the whole authorised capital. He would never have been able to make an inch of railway in his life, if the entire capital had had to be subscribed before the line was begun. That requirement had been found to be so absurd in the early days of railways that Parliament withdrew it. Public interest in this question of light railways was increasing, and to the public they must look for the necessary pressure on Parliament and the Board of Trade for the legislation required. The construction of these lines would give employment to a great mass of the unemployed labour, would draw back the unemployed from the towns to the country, and we should no longer have the youth of the country pouring into the big towns.

Mr. LEGGETT said some of the lines in Wales, though not exactly light, were yet worked under relaxations of the usual conditions. One paid 6½ per cent., but two others did not pay their way. They carried no less than 33,000 passengers in 1893, 200,000 tons of goods, general merchandise, mails, and parcels. Those lines paid on their aggregate capital an average of 2¼ per cent. Reasonable speed was required in order to attract passengers, and for the lines to pay proper provision must be made for passenger traffic. Worked at first by horses, after the introduction of steam traction, in 1879, the traffic increased some 600 or 700 per cent. In one purely agricultural village, it had risen 2,500 per cent. If the speed was limited according to the Tramway Act people would not use the lines. People had asked for the rates to be raised in order that the lines might pay and continue to be worked, to prevent districts being entirely cut off and people thrown out of work.

Mr. PRICE WILLIAMS said the vital question was the cost of these lines. If it were made too heavy, the result would be disastrous, as had happened in Ireland. In the paper, a hope was expressed that the time might come when these light agricultural lines, instead of costing £10,000 per mile, would be made for £5,000. If they were to cost anything like £5,000, there was not the remotest chance of their ever being made in agricultural districts. From his experience in the colonies, he was satisfied that, even allowing for the cost of strips of land required, the outside cost would not be more than £2,500 per mile, assuming, as he hoped would be the case, that the Board of Trade would largely relax the present onerous requirements.

The CHAIRMAN asked whether that estimate included rolling stock?

Mr. PRICE WILLIAMS said that on lines constructed of the standard gauge the ordinary rolling

stock would be employed; the estimate included light engines to work the traffic. A slight traffic of £3 per mile per week would not only pay expenses, but 4 per cent. upon the capital outlay. The help the legislature could give would be in removing restrictions in order to obtain the traffic. If they wanted to avoid making these railways a complete failure they should take Ireland as a warning. Under moderate conditions, there would be a reasonable prospect of these lines paying. In Ireland the lines had been so hampered with the cost of working that it was hopeless to expect them ever to pay. Neither the assistance of the State nor that of the ratepayers need be called in if those simple conditions of construction were carried out.

Mr. W. J. CARRUTHERS WAIN said the idea that these railways must of necessity be expensive *per se* was easily got rid of. The second paragraph of the minority report by Mr. Stephen Sellon, Sir Albert Rollit, and himself, of the Committee on Light Railways stated that, to relieve the congested districts; to afford communication between urban and suburban districts, and also to provide facilities for the transit of passengers and goods from and to the great cities, large extensions of the existing tramway systems would be most advantageous and naturally would not necessitate the purchase of valuable land, either for terminal stations, or for carrying the lines through towns and would, in addition, get rid of terminal charges, and the construction of the most costly works of a railway, viz., tunnels, cuttings, embankments, viaducts, or bridges, stations, and expensive signalling and interlocking apparatus. In many cases such lines could be made at the sides of the roads, or on the waste land at the sides, thus avoiding any extensive interference with the public highways. That was distinctly laid down by influential members of the Committee, and the fact ought to attract public attention because it was the cheapest and most easy way of dealing with the question. Then as to the cost of promotion, they made the following suggestion:—"With a view to reducing the cost of promotion, we recommend that instead of the present mode of procedure it is desirable that Parliament should authorise the Board of Trade to sanction the construction of light railways, tramroads, or tramways, which are approved by the County Council concerned, and in cases where several County Councils are interested, the Board of Trade, after holding a local enquiry, should have power to overrule the objections of the minority." In reference to the opposition of frontagers, the minority report stated: "As under the present standing orders affecting tramroads and tramways, one frontager has prevented bills being considered on their merits, we recommend in all cases of opposition by frontagers, that claims both as to opposition and compensation, should not prevent a bill or order being considered on its merits, and if the proposed line is shown to be of public utility, the opposition of such frontager or frontagers should be overruled." As to the compulsory acquisition of land there was no reason why the power given to public authorities for that purpose by the Act of last Session should not be extended to this object, and it was advisable that the valuers should be appointed by the Board of Trade. It was no use anybody thinking they were going to get public money for private enterprise by the great railways, on light railway conditions and cost, for this purpose, unless they could pay people five or six per cent. upon their money. If that could have been done, light railways would have been made long ago. But with a County Council or Government guarantee of 2¾ or 3 per cent., or on the Belgian principle of the capital being raised in certain proportions by the State, the commune, and the public, they would be able to get the money to-morrow. The nonsense that had been talked in the House was by those who really ought to know better, and from that side of the House which professedly represented agricultural interest; and while it is absurd to suppose that the provision of light railways would alone cure the evil of agricultural depression, at least it would be a great step in the right direction, and could not fail to be as beneficial to the English agriculturalist as it has been found to be in France, Belgium, Italy, &c.

The CHAIRMAN requested, on account of the late hour, that any other remarks might be sent in writing to the Secretary, and asked the meeting to join him in thanking Mr. Acworth for his admirable paper.

Mr. ACWORTH, in acknowledging the vote of thanks, said, in reference to the lines paying 6 per cent. instead of 3 per cent., that must depend on the cost of construction, and on working expenses. He could not allow the idea that the Irish light railways were a failure, or anything like it to go forth without protest. Light railways had no doubt been of great benefit to the Irish people. As to £5,000 being an extravagant estimate, too many lines had been shipwrecked by talking of £2,500 and then finding £5,000 was wanted. It would be preferable to say £5,000, and then, if it was found only £3,000 was required, so much the better.

Mr. PRICE WILLIAMS said his point was that, if that amount had to be paid, the lines would not return so much per cent.

Mr. ACWORTH said that any man who talked of a line earning only £3 per mile per week, did not recognise facts. Mr. Harrison, an acknowledged authority as an engineer, used to say that a line could not be put down in England that would not earn £6. He could not then go into details to shew that he was right in saying that the cheaper lines must earn higher rates, but would be happy to argue the point at some future time.

Mr. F. McDermot writes:—I would suggest that before the general public will invest in light or any other new railways in rural districts, some guarantee will have to be given that the rates sanctioned by Parliament, and on the faith of which the funds would be subscribed, will not, within a few months of the opening of the line, be seriously reduced by Parliament on some agitation for further protection for the agricultural interest. After a very long inquiry certain rates have recently been fixed by Parliament, and already there is a growing agitation for further reductions and modifications.

Miscellaneous.

EUROPEAN EMIGRATION TO THE UNITED STATES.

The United States Bureau of Statistics has recently issued a report dealing with the question of the current of European emigration to the shores of that country. Returns are given showing the volume of this emigration for the last ten years. During this period, of all the countries furnishing the emigrants, Germany takes the lead. From no other country have nearly so many immigrants arrived in the United States, except once, in 1888, when 103,692 persons came from England, Scotland, and Wales. In that year, 109,712 German immigrants landed, and in the next year the figures were—Germans, 99,538; English, 87,992. The sources of the new foreign population of the United States change from time to time. There was a period, beginning before the middle of the century and following the great famine, when the bulk of the immigration was from Ireland. That period has long since passed, and not only is the Irish immigration exceeded by the German, but also by that from a number of other countries. In 1885, 1886, and 1887, it was exceeded by the immigration from England, Scotland, and Wales. In 1888, it was also less than that from Denmark, Sweden, and Norway. In 1891, it was exceeded also by that of Russia, and Poland, and Italy. In the year ended 30th June, 1894, these countries were all ahead of Ireland, except the Scandinavians, whose immigrants numbered about 900 fewer than the Irish immigrants. The Irish and Germans appear to go to the United States with the object of permanently establishing their homes there, and they bring their families with them. In 1893, the Irish women immigrants outnumbered the men by about 1,500, indicating that domestic service in the United States would appear to have more attractions to the peasant girls than day labour has for unmarried Irishmen. Of the 95,361 Germans who went to the United States in the same year, 54,394 were men and 41,967 were women—a considerable proportion in favour of the former. It would appear from the returns that the Italians, Hungarians, and Bohemians go to the United States for the purpose of making as much as possible by their labour, and then returning to their native countries. The immigration from these last and the other countries was divided between the sexes as follows:—Hungary and Bohemia, 20,099 men and 8,950 women; other parts of the Austro-Hungarian Empire, 21,183 men and 9,401 women; Italy, 57,757 men and 15,139 women; Russia and Poland, 35,964 men and 21,528 women; Scandinavia, 36,549 men and 26,386 women; and England, 35,732 men and 24,121 women. Assuming that the immigration of women indicates a permanent movement, and that those who arrive in the United States with their families intend to remain in the country and to become American citizens, the people of the different countries may be arranged as to their permanence in the following order:—(1) Ireland, (2) Germany, (3) Scandinavia, (4) England, Scotland, and Wales, (5) Russia and Poland, (6) Austria, including Hungary and Bohemia, and (7) Italy. The volume of immigration into the United States was much smaller in the year ending June, 1894, than it had been in any previous year for a long time. In the year ended 30th June, 1891, it was 560,319; in 1892, 623,084; in 1893, 502,917; in 1894 it was only 311,404. The falling off was by far the greatest in the Slav immigration. The decrease in the number arriving from Russia and Poland alone was from 117,692 in 1892, to 39,124 in 1894.

CINCHONA GATHERING IN PERU.

The mountains of Peru form the natural home of the cinchona-tree, which is easily distinguishable from surrounding foliage by its beautiful leaves and magnificent proportions. The trees themselves frequently attain a height of eighty feet, are straight as a lance, and covered with foliage. The leaves are large and of a deep glossy green, relieved by delicate pink lines, producing a beautiful effect in the sunshine of that country. Since 1638 the medicinal properties of the cinchona-tree have been known in Peru. The life of a *cascarillero*, or bark-hunter, is one of constant toil and incessant hardship, and his main reliance on his long and solitary journeys in search of the bark is the coca leaf, which he masticates for the strengthening and stimulating qualities it possesses. Since the days of the Incas this coca has been in common use locally, and it is said that among the mountains of Bolivia and Peru, Indians using coca freely when driving pack mules over the roughest roads along the Sierras outstrip well-mounted horsemen. From thirty to fifty grammes are consumed daily, serving both as food and stimulant. The *cascarillero*, constantly using coca, finally loses the senses of taste and smell. There are many varieties of cinchona, which the hunter learns to distinguish

through the texture and appearance of the bark. They are red, white, orange, yellow, blue and grey; the yellow being the finest. Although the pay of the quinine-hunter is very small, it suffices to meet the simple requirements of himself and family, and as a class they are happy and contented with their lot. It is a vocation that is handed down from father to son, but, despite long years of experience, coupled with an intimate knowledge of the intricate trails leading to the cinchona-tree, the Indian hunters frequently lose their lives in the jungles of the wilderness. Occasionally, a number of hunters start together as a greater protection against disaster. Upon reaching a desirable spot where the signs of paying trees are considered good, preparations for camping are at once made, and from the tops of the loftiest trees the hunters scan the forest, quickly recognising the cinchonas. The task of gathering cinchona bark occupies all the working hours between sunrise and sunset. Armed with knives and keen-edged hatchets, the tree is quickly felled and the trunk is stripped and cleared from all foreign growth. This is a task of considerable magnitude, frequently requiring days of constant labour, the sharp edges of lance-like leaves, mingled with thorns and briars, lacerating and wounding the hunter's flesh. The bark, when removed, is cut into small curling slips and piled up in a convenient spot, where they are subjected to a drying process. The thin portions of the bark curl up, drying rapidly, while the larger and thicker strips retain their shape and are easily packed for transportation. When all is pronounced ready by the *torlego*, or head hunter of the party, the bark is neatly lashed together with plaited grass and bound round with broad tough leaves, as a protection to the cured bark. The Indians and *peons* then shoulder their burdens, often weighing as much as one hundred and fifty or two hundred pounds—these are kept in position by plaits of grass passing round the foreheads of the bearers, and are thus carried to market.

General Notes.

Paris Exhibition, 1900.—The Paris correspondent of the *Standard* gives the following account of the arrangements for the Exhibition of 1900:—"The Commissary General of the Exhibition of 1900 has just settled the general plan of that great international show in accord with the projects which obtained awards at the recent competition. The principal points of the programme are as follows:—The suppression of the Palais de l'Industrie in the Champs Elysées, and the creation of a great road connecting the Champs Elysées with the Place des Invalides, with a monumental bridge over the Seine. The Palais de l'Industrie is to be replaced by a new edifice. The principal entranee to the Exhibition will be on the Place de la Concorde. All that concerns decorative art and that has a distinctly French character will be grouped along the Cours de la Reine and on the Esplanade des Invalides. The Electricity Palace will be close to the principal entrance. The banks of the Seine will be made as decorative as possible. The Champ de Mars, where the Eiffel Tower will be preserved, will be occupied by what may be called cumbersome exhibitions, such as agricultural machinery. The machinery gallery of 1889 Exhibition will be allowed to stand but it will be decorated with a huge dome, and will be again occupied by machinery. The Fine Art and Liberal Arts Palaces will be suppressed. The Champs de Mars will be levelled, and will rise in an inclined plane from the Seine to the machinery gallery. The Colonial Exhibition will be at the Trocadéro."

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock:—

February 20.—"Rule of the Road at Sea." By Admiral P. H. Colomb.

February 27.—"Furnaces for Roasting Gold-bearing Ores." By C. G. Warnford Lock.

March 6.—"Cider." By C. W. Radcliffe Cooke, M.P. Sir George Birdwood, K.C.I.E., will preside.

March 13.—"Our Food Supply from Australasia." By E. Montague Nelson. Sir Frederick Bramwell, Bart., D.C.L., F.R.S., will preside.

March 20.—"The Progress of the Abattoir System in England." By H. F. Lester, Hon. Secretary to the London Model Abattoir Society. Sir Benjamin W. Richardson, M.D., F.R.S., will preside.

March 27.—"Modern Photogravure Methods." By Horace Wilmer.

April 3.—"Sand Blast Processes." By John J. Holtzapffel.

Foreign and Colonial Section.

Tuesday evenings, at Eight o'clock:—

February 19.—"Paraguay." By A. F. Baillie, Consul in London for Paraguay. Lieut.-General Sir Andrew Clarke, G.C.M.G., C.B., will preside.

Applied Art Section.

Tuesday Evenings, at Eight o'clock:—

February 26.—"Mediæval Embroidery." By Mrs. May Morris Sparling. Alan S. Cole will preside.

Cantor Lectures.

Monday Afternoons, at Four o'clock :—

Alan S. Cole, "Means for verifying Ancient Embroideries and Laces." Three Lectures.

February 18.—Lecture II.—Types of Assyrian and Greek textile ornaments compared—Homer's references to ornamental textiles—Grecian women and embroidery—Lighter kinds of embroidery produced by Greeks than by Egyptians, Assyrians, and Persians—Examples of textile ornaments taken from Greek vases of Sixth Century B.C.—Varieties of embroideries taken from Græco - Scythic tombs of Third and Fourth Centuries B C.—Fresh varieties of ornament displayed in actual specimens of Egypto-Greek, Egypto-Roman, and Saracenic work—Saracenic and Byzantine specimens (about Eighth or Ninth Century A.D.) of silk and linen work—Early Christian emblems in embroideries.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 18...SOCIETY OF ARTS, John - street, Adelphi, W.C., 4 p.m. (Cantor Lectures.) Mr. Alan S. Cole, "Means for Verifying Ancient Embroideries and Laces." (Lecture II.)

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. A. Kapteyn, "Apparatus for Making Lantern Slides by Artificial Light."

Imperial Institute, South Kensington, S.W., 8½ p.m. Captain W. de W. Abney, "The Eye and Photography."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Arthur Pain, "Light Railways."

Medical, 11, Chandos-street, W., 8½ p.m. Dr. Schofield, "The Evolution of the Natural and the Artificial."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. Canon Benham, "Dickens's London."

Tuesday, Feb. 19 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. A. F. Baillie, "Paraguay."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "Internal Framework of Plants and Animals." (Lecture VI.)

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. J. Castell-Evans, "Physics and Chemistry." (Lecture V.—The Chemistry of Fuel and Combustion.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Statistical, Geological Museum, Jermyn-street, S.W., 4¾ p.m. Mr. R. F. Crawford, "An Inquiry into Wheat Prices and Wheat Supply."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. F. E. Beddard, (i.) "The Brain of *Gulo*," (ii.) "The Brain in the Lemurs." 2. Mr. C. Davies Sherborn, and Dr. F. A. Jentink, "The Dates of the Parts of Siebold's 'Fauna Japonica,' and Giebel's 'Allgemeine Zoologie'" (first edition).

Wednesday, Feb. 20 ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Admiral P. H. Colomb, "Rule of the Road at Sea."

Meteorological, 25, Great George-street, S.W. 7½ p.m. 1. Mr. Edward Mawley, "Report on the Phenological Observations for 1894." 2. Mr. William Marriott, "The Thunderstorm and Squall of January 23rd, 1895." 3. Mr. Alexander B. McDowall, "Some Gradual Weather Changes in certain Months at Greenwich and Geneva."

Geological, Burlington-house, W., 8 p.m. 1. Mr. J. W. Gregory, "Contributions to the Palæontology and Physical Geology of the West Indies." 2. Mr. J. D. Kendall, "The Whitehaven Sandstone Series." 3. Miss Jane Donald, "Notes on the Genus *Murchisonia* and its Allies, with a Revision of the British Carboniferous Species and Descriptions of some new Forms."

Microscopical, 20, Hanover-square, W., 8 p.m.

Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. J. W. Tutt, "An attempt to correlate the various Systems of classification of the *Lepidoptera* recently proposed by various authors." 2. Rev. T. A. Marshall, "A Monograph of British *Braconidæ*, Part. VI."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Discussion on Mr. A. V. Newton's paper, "Industrial Progress in the Arts, and how it may be encouraged or retarded." 2. Paper from a German Correspondent on "Dependent German Patents."

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. A. W. Dollond, "A Toning Process for Platinum Prints."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Thursday, Feb. 21...Electrical Engineers (at the House of the Society of Arts), 8 p.m. Dr. John Hopkinson, "Propagation of Magnetism in Iron."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. J. J. Boerlage, "*Chionanthus Ghaeri*, Gaertner." 2. Mr. E. M. Holmes, "New Marine Algæ from Japan."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. A. P. Laurie, "The Electromotive Force of an Iodine Cell." 2. Messrs. Cross, Bevan, and Beadle, "Contributions to the Chemistry of Cellulose." 3. Mr. H. Crompton and Miss M. A. Whiteley, "The Melting Points of Mixtures." 4. Messrs. J. Reddrop and H. Ramage, "The Volumetric Determination of Manganese."

London Institution, Finsbury-circus, E.C., 7 p.m. Professor W. H. Cummings, "National Song."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. L. Fletcher, "Meteorites." (Lecture II.)

Historical, 20, Hanover-square, W., 8½ p.m. Annual Meeting.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. R. Elsey Smith, "A Visit to Greece and Cyprus."

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. George Davison, "Photography, as Applied to the Production and Reproduction of Pictures."

Friday, Feb. 22.—Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. A. Schuster, "Atmospheric Electricity."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. J. Castell-Evans, "Physics and Chemistry." (Lecture VI.—Sanitary Chemistry.)

Clinical, 20, Hanover-square, W., 8½ p.m.

Saturday, Feb. 22...Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander Campbell Mackenzie, "Moore's Irish Melodies," with musical illustrations by Mr. C. Hutchinson and Mons. Emile Sauret.

Journal of the Society of Arts.

No. 2,205. Vol. XLIII.

FRIDAY, FEBRUARY 22, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Mr. Alan S. Cole delivered the second lecture of his course on "Means for verifying Ancient Embroideries and Laces," on Monday afternoon, 18th inst.

The lectures will be printed in the *Journal* during the summer recess.

PRIZES FOR PHOTOGRAVURE.

With the view of encouraging the development of Photogravure in this country, the Society of Arts offer the following Two Prizes:—

(1). A Prize of Twenty Pounds or a Gold Medal* for the best reproduction of a selected picture by a Photogravure process.

(2). A Prize of Ten Pounds and a Silver Medal for the best Photographic Negative of a selected picture, suitable for reproduction by a Photogravure process.

The following are the conditions of the offer:—

The offer is limited to British subjects.

The Committee have selected as a suitable test picture, Mulready's "Choosing the Wedding Gown," now in the South Kensington Museum, and the Lords of the Committee of Council on Education have kindly consented to allow the picture to be used for the purpose.

Competitors will be allowed to photograph the picture, which will be placed for the purpose in the Photographic Studio of the Science and Art Department.

Competitors should apply to the Secretary of the Society of Arts, who will provide them with an order to photograph the picture, and will also see that the necessary arrangements for the purpose are made. Such applications must be received not later than the 30th March. A dark room is attached to the studio so that competitors can develop their plates on the spot.

Competitors for Prize No. 1 will be expected to send in a finished proof from the plate, the plate itself, and the negative from which the plate was made.

Competitors for Prize No. 2 will be required to send in the negative and a print from it. (This print may be in silver, carbon, platinotype, or other process.)

The negatives for both prizes must be taken on plates 12 × 10 inches, and the finished picture must be of corresponding size. The actual size of the original without the frame is about 21 × 18 inches.

The photographs and photogravures must be wholly untouched. Any work on the negative or plate will be held to disqualify the competitor.

The prints, plates, and negatives must be sent in to the Society of Arts not later than the 15th of May next.

The winner of Prize No. 1 will not be disqualified for Prize No. 2.

The photographs, negatives, and prints will be returned to the competitors after the decision of the judges has been announced, but the Council of the Society reserve to themselves the right of exhibiting all or any of the works sent in.

The judges will be the Committee nominated by the Council:—Major-General Sir John Donnelly, K.C.B., Chairman of the Council; Sir Frederic Leighton, Bart., P.R.A., H. T. Wells, R.A., E. J. Poynter, R.A., Francis Cobb, Thomas Armstrong, Capt. W. de W. Abney, C.B., F.R.S., and Sir Henry Trueman Wood, Secretary.

The Council reserve to themselves the right of withholding either or both of the prizes, or of awarding smaller prizes, if they think it desirable to do so. The Council also reserve the right of declining to accept, at their discretion, any application for orders to photograph the picture.

The Council will not be responsible for any loss of, or damage to, works sent in.

* Should the winner of the prize elect to take the award in money, a Silver Medal will be given in addition to the sum of Twenty Pounds.

Proceedings of the Society.

INDIAN SECTION.

Thursday, February 14, 1895; SIR CHARLES ARTHUR TURNER, K.C.I.E., in the chair.

The paper read was—

VILLAGE COMMUNITIES IN SOUTHERN INDIA.

By C. KRISHNA MENON,

Lecturer on Agriculture at the Sydapet College, Madras.

The existence of village communes in India was first brought to the notice of Western thinkers by the writings of the late Sir Henry Sumner Maine. His great work, "Village Communities in the East and West," once for all exploded the theory which was till then the sheet-anchor of Imperialists, that in India, land, from time immemorial, belonged absolutely to the State, and that the cultivators held the land and tilled it on sufferance. Sir Henry proved to the hilt that the tenure of land in India was what modern Socialists would call "collectivism," *i.e.*, a village was held by the villagers in common and cultivated in common, and the produce shared in common. No doubt the State was a shareholder, but, as I shall prove later on, a very small shareholder. The early British occupiers paid very little attention to the ancient institutions of the country. Their ideas of government were what they inherited from their Mohammedan predecessors. The Mohammedan theory was that the land belonged to the State, and they practised accordingly. But it should be said to the credit of the Mohammedan conquerors that they did not disturb the *status quo*. They came not only as conquerors but also as colonists, and they found it to their advantage to leave the internal organisation unimpaired. All that the Mohammedans did was the introduction of a military settlement whereby a congeries of villages, in themselves autonomous, were blackmailed to maintain a military commander and his retinue. This was, no doubt, an infringement on the village rights, as the villagers were compelled to contribute more than the customary quota for purposes of administration. This disturbance in the village organisation did not result in its dismemberment; it only checked its further development into a more extended democratic federation. That the Hindu village communities had an internal vitality strong enough to withstand foreign aggression has been fully borne out by Sir C. Metcalfe in his evidence before the House of Commons in 1832.

"They [the Hindu communal institutions] seem to last where nothing else lasts. Dynasty after dynasty tumbles down; revolution succeeds revolution; Hindu, Pathan, Mogul, Mahratta, Sikh, English, are all masters in turn; but the village community remains the same. In times of trouble they arm and fortify themselves; an hostile army passes through the country; the village committees collect their cattle within their walls and let the enemy pass unprovoked. If plunder and devastation be directed against themselves, and the force employed is irresistible, they flee to friendly villages at a distance; but when the storm has passed over, they return and resume their occupation. If a country remain for a series of years the scene of continued pillage and massacre, so that the village cannot be inhabited, the scattered villagers nevertheless return whenever the power of peaceful possession revives. A generation may pass away, but the succeeding generation will return. The sons will take the place of their fathers; the same site for the villages, the same position for the houses, the same lands will be reoccupied by the descendants of those who were driven out, for they will often maintain their post through times of disturbance and convulsion, and acquire strength sufficient to resist pillage and oppression with success. This union of the village communities, each one forming a separate little state in itself, has, I conceive, contributed more than any other cause to the preservation of the people of India, through all the revolutions and changes they have suffered, and is in a high degree conducive to their happiness, and to the enjoyment of a great portion of freedom and independence."

The village commune, which played an important part in the social and political history of India for more than 2,000 years, and which even withstood the fiery sword of the Moslem, is now a thing of the past, nay, is considered by some to have been drawn out of the realms of fabulous antiquity. Hardly one hundred years of British administration has succeeded in completely sweeping away even the vestiges of a deep-rooted institution which had stood the shock of mighty revolutions for over 2,000 years.

Before I give an account of these institutions, I must express my regret that neither the Government of India, nor students of comparative history, nor lovers of jurisprudence, have given anything like adequate attention to this ancient institution, which, in the opinion of jurists like Sir Henry Maine, was the unit of a self-governing, self-sufficing democratic

municipal institution. The work of Sir Henry Maine, however interesting to a student, is very meagre regarding the interdependence and interrelation of these communes to one another. Sir Henry is alive more than any other to the inadequacy of the materials with which he had to work out. So far as the internal management of a single commune is concerned, Sir Henry has given us a very faithful account; but he has very little to say regarding the relationship of one commune to another. This is the most important. Sir Henry Maine throws a doubt whether the various communes ever met through their representatives to discuss questions of common polity such as the management of temple affairs, the construction of irrigation works, and the distribution of water to various villages, &c.; in fact, whether the Hindus ever rose beyond the independence of a village commune. In this paper I shall attempt to prove that the autonomous village communes combined for various purposes, worked in harmony through their representatives on questions of common interests such as temple management, construction of irrigation works, &c., in fact, from a small village union, or *panchayat*, the assembly of five, they rose to representative municipal organisations which successfully carried out and maintained great public works of irrigation and transit without raising a loan. Evidences are not wanting to prove that these municipal organisations met in grand assembly round the king's throne and they dictated terms to the king; in fact, it could be shown that under purely Hindu institutions there was no absolute monarchy, that the people were, and are, fully able to manage their internal affairs. What, then, was a Hindu village commune? Had it any counterpart in the West? Sir Henry Maine has clearly shown that a Hindu village commune was exactly like a Teutonic mark as described by von Maurer:—"There is the arable mark, divided into separate lots but cultivated according to minute customary rules binding on all. There is the waste or common land out of which the arable mark has been cut, enjoyed as pasture by all the community *pro indiviso*. There is the village, consisting of habitations each ruled by a *paterfamilias*. There is constantly a council of government to determine disputes as to custom." In the management of the arable mark, the Hindu village communes followed two methods. One is called *samudayam*, by which the village was cultivated by a joint stock of labour, cattle and implements, the produce being shared by the members of the village community according to their respective shares. The other is known as *kareiyedu*, by which the lands were temporarily distributed by lot into separate shares and were subject to periodical redistribution. There is no doubt but that the *samudayam* was the more ancient system, and that the *kareiyedu* represents a stage in the development of village communes. In the Teutonic mark von Maurer treats only of the *kareiyedu* type, the arable mark being divided into several lots amongst the members of the commune, and subject to periodical redistribution. Perhaps earlier evidences are not forthcoming to prove the existence of the *samudayam* system under the Teutonic mark. The *kareiyedu* exists even to this day in some remote parts of Tanjore and Chingleput. The most remarkable feature of the *kareiyedu* system is the recognition of the absolute principle of collectivism in conformity with the idea of individualism. The whole system has an ethical basis. Modern Socialists would find many agreeable surprising features, while, at the same time, the economist of the *laissez faire* school would catch a veritable Tartar in it. The *kareiyedu* system is not one enveloped in the mists of antiquity; we have authentic records of the operations of this system. As late as 4th July, 1864, the *kareiyedu* was worked in its entirety in the Tanjore district. Sir Henry Stokes gives us a graphic account of this redistribution which clearly brings into prominence the genius of the people for self-government. "The manner in which the redistribution of the land takes place will best be described by an example. In a village, say, of 20 *velis* (1 *veli* = 6·6 acres), a certain unit is fixed on, which is called a *pangu*, or share, and in some villages 1 *veli*, and in others varies from 1¼ to 3 *velis*. The village is divided according to its extent into from four to ten *kareis* or blocks, to each of which so many shares are allotted. Thus, in a village of 20 *velis*, there might be 15 shares apportioned to four blocks of land among 12 shareholders, each block containing the land of three shareholders. In the months of June, July, or August, before the seed is sown, the operation of division, or *kareiyedu*, commences. First of all the whole area of the village is measured, and a measurement account prepared. Then for each *karei* (block) a headman is chosen from the landholders, who is known as the *karei karan*, the manager or master of the *karei*. He is

generally one of the largest shareholders in the village; though, if he cannot read and write, the larger holder is passed over in favour of the smaller one who can. He is appointed by the common consent of the sharers who are allotted to the *karei* of which he is to be the head, and retains his position until the next division takes place. If he dies before that time, or sells his property, his office does not pass by inheritance nor to the purchaser. No new appointment is made; and the name of the original *karei karan* is attached to the *karei* throughout the time during which the distribution of the land is to remain in force. When he has been chosen, and when certain shareholders have been allotted to each *karei*, an agreement is executed by them to abide by the *karei karan* and the allotment, and binding themselves to execute the necessary repairs and improvements, and to carry out certain other arrangements. Then the lands of the villages are divided, without reference to previous enjoyment, into so many shares—fifteen in the case we have taken. These again are embodied in four *kareis*. Then a slip of *kadjan* (palm-leaf), called *karieyolei*, is prepared for each of the four *kareis*, and on it are written the names and extent of the fields composing the *karei*. Four other smaller slips are inscribed with the names of the *karei karan*, each bearing one name; and then all the eight slips are thrown down together on the ground. A child, four or five years old, who cannot read, is sent to pick out a large and a small slip, and this decides the *karei* and the *karei karan*. The lots are drawn in a public place either before the village temple or the village *chatram*. The lots are drawn on an auspicious day fixed with regard to the position of the star of the village. Before the drawing, an offering is made to the presiding deity, and as many cocoanuts are broken before it as there are shareholders. After the lots are drawn, an agreement is entered into, which agreement is entrusted to the village priest. Each shareholder then takes a copy of the agreement for reference whenever necessary. The agreement drawn up is a remarkable document. It clearly shows how these simple villagers can draw up thorough business-like documents, with none of those sharp practices that we find in the productions of modern pettifogging attorneys. It once more illustrates Rousseau's statement that the idea of justice is innate in man. How equitably the rights of the minority are preserved! And how rigidly are the terms laid down for carrying out works of common utility! Here are a few extracts from an agreement entered into by a few Tanjore cultivators, and published in the Tanjore Manual: "Moreover, as it is necessary to provide for the repair and restoration of the temples in the above villages which have fallen into disrepair; for that purpose. . . In such manner must the income of the several years be employed in the service of the said temples." Again about the rights of Pariahs: "In accordance with what is proper for cultivating tenants and others, the Pariah street, the Chuckler's street, shall be measured according to the former perpetual division. 'He who has too much shall give up to him who has too little.'" Regarding irrigation the following terms have been laid down:—"And for all lands as aforesaid, the irrigation and drainage shall be maintained according to custom. If a scarcity of water occurs, an agreement must be drawn up specifying the turn of each cultivator for taking water from the channel, and the length of time he may so take it, and the irrigation shall be conducted accordingly. A double dam shall be made east of the *kidaran koudan* sub-channel, and the water led on to the wasted *kadamban* field. A sub-channel shall be cut from the Muleimangalam channel, and the water led on to the aforesaid field. In all other places irrigation shall be carried on according to agreement." . . . "None of the aforesaid lands can be sold outright by a sharer and, even if so sold, the sale shall be null and void. In all affairs which have to be carried on in the village, the practice laid down in former agreements has to be followed. To this effect have we all with one consent agreed." I wish our district authorities in the Presidency of Madras would ponder over these facts. To them and to the irrigation engineers have been allotted the arduous duty of distributing water, and the petitions and counter petitions with which they are troubled by the villagers are without end. Fresh rules are enacted to avoid difficulties; but the difficulties only increase. Let them carefully study the methods adopted by the people before the British occupation, and let them work on those lines. There will be deliverance to the people, to the officials, and to the impoverished treasury. Is it not an irony of fate that the people who till recent times carried out and maintained grand irrigation works, which have no parallel in the world's history, which have stood the ravages

of time, and which called forth the admiration of such an hydraulic engineer as Sir Arthur Cotton, should now be considered quite incompetent even to manage a petty village tank which perhaps irrigates a few acres?

I have digressed a little from the main line of argument, *i.e.*, the constitution of a Hindu village commune. Now, the organisation of a village commune in the Madras Presidency is complete even to minuteness. Its constitution is democratic, self-sustained, self-sufficing. It has all the features of a highly-organised society, like one of the cantons of the Swiss Republic. Its functionaries are various, and are answerable only to the village, there being no representative of the paramount power to be answerable. The village consists of an elective body called the *panchayat*, or the assembly of five elders. There was no hereditary chief or headman, but one of the five officiated as the head at the deliberations of the council. Then there were a host of minor officials to carry out the executive work of the commune. These may be enumerated as follows:—

(1) *Karnam*, accountant, whose business is to keep the village register, showing the area cultivated each year by each sharer, the extent of the land irrigated, and other matters pertaining to agriculture.

(2) *Nirgunti*, distributor of water for irrigation purposes.

(3) *Talayar*, village watcher, who is otherwise known as the village police.

(4) *Vettyan*, village scavenger, who has to look to burials, cremation, &c.

(5) Schoolmaster.

(6) Doctor.

(7) Astrologer, or the village meteorologist, who is to give a forecast of the weather, the time for sowing, harvesting, &c.

(8) The priest.

(9) The washerman, barber, potter, carpenter, smith, &c.

All these officers and functionaries had a share in the produce of the soil. The constitution of the village government was essentially a body democratic. According to Mr. Ellis, "the duties are discharged by the village senate, *gramapravarticam*." In this assembly every sharer has a seat and a voice. It is from these village assemblies, or *panchayats*, that representatives were sent to the larger assembly which looked after the common interests of several villages as in the matter of road conservancy, irrigation, temple management, &c. For it is a well-known fact that although these villages were self-contained units in themselves, they were simply part of a whole machinery, a wheel within a wheel. In Southern India irrigation is an important factor in agriculture, and the genius of the people has left indelible marks in the grand irrigation works constructed and maintained by them. To carry out these gigantic works co-operation on a grand scale was necessary. Each village cannot have its own irrigation work quite independent of the neighbouring villages. The irrigation tanks are, therefore, constructed at convenient centres which have the command of several villages, and the water is carried from these tanks by means of channels which pass through several villages. An admirable system was organised to carry out these extensive works without let or hindrance. The duly elected representatives of several villages formed into a state or municipal conservancy, known as *grama samudayam*, and they presided over a department known as *kudimaramalt*, village conservancy and village public works department. These had the control of the free labour of each village which is irrigated by the tank. The portion of the canal that passes through each village was constructed and maintained by the free labour of the village. Disputes seldom arose, because there were the representatives of the villagers on the spot to see that the rights of each village was maintained. It has been the fashion for many writers to maintain that these grand works were done by slave labour, or forced labour, for they could not bring themselves to believe that the Indian nation could at any moment combine for mutual aid. This view, I regret to state, has been urged even by a few Hindu gentlemen high in the service of State. It simply shows the utter ignorance of the past history of their country. No doubt, the free labour of the people contributed to the village conservancy became one of forced labour during the early British occupation, when a heavy tax was imposed on the water, at the same time compelling the villagers to give free labour. Fortunately this system does not exist now. But it served in the hands of interested parties to curb the native genius for self-help. It is often pointed out that it was through sheer necessity that the Government was compelled to take charge of these irrigation works as the people were found quite unable to manage them. A little reflection would awaken these people to the fact that for hundreds and

thousands of years the Hindus were managing their own affairs without a major and a minor irrigation department. Besides the representative body for looking after the agricultural interest, there was also a body for managing temples, charities, endowments, &c. This is called the temple *samudayam*. Every temple which is common to several villages had a *samudayam*, or a representative body to manage all temple affairs. Even in spiritual matters the paramount power, the king, has no voice except as the president of a *referendum*, which I shall explain later on. To illustrate my point more clearly, I shall take the practice of Malabar, a country which was till the beginning of this century a purely Hindu kingdom, and which, therefore, retains many of the customs in their pristine purity. A temple has three functionaries—*ooralan*, the syndic of the village in which the temple is situated; the *samudayam*, or the representative body that has a supervision over the syndic; and then the *melkoyima*, or chief supervisor, who is the king. The *ooralan* is the executive functionary who looks after the immediate management of the temple. No doubt, in recent times, owing to the ignorance of the English judges, many of these *ooralans* have been transformed into absolute proprietors of the temple and its extensive interests. But to a student of comparative history the change is not at all surprising. Besides the village *panchayat* and the *samudayam*, there was another assembly which was of great importance, This was the *cheri*, *karei*, or *sangam*. I shall explain the three stages of Hindu self-government by three modern institutions. The *panchayat* corresponds to the vestry, the *samudayam* to the municipal board, or county council, and the *cheri* or *karei* to the grand assembly. The *karei* meets with the king as its president in discussing questions of national importance, in which the interests of several towns and villages are concerned. That this was actually the case can be learned from several documentary evidences, known as *sasanums* or deeds granted on certain occasions. A remarkable document in the possession of the Jews of Cochin in Malabar is the copper-plate deed given by the king of Malabar about 70 A.D. when the Jews took shelter on the Malabar coast after Jerusalem was sacked by the Romans. This deed conclusively shows that the king was simply the president of the assembly, which contained 600 members. The deed was given in the name of the king and the 600 nairs. Later on, about the 15th century, when Vasco da Gama had several encounters with the Zamorin of Calicut, he mentions the thoroughly democratic constitution of the country. In Travancore, another ancient Hindu State, the king established his absolute power only in recent times. It was the Western nation that gave him the absolute sovereignty, for, it was their interest at the time that he should emasculate the people. A civil war of an atrocious nature broke out, and it was the powerful artillery of Europe made the king absolute sovereign. Having by the powerful aid of Europeans destroyed the independence of the people, the king now claims absolute sovereignty over the soil, and takes a large share. Our statesmen point out this fact as showing that during the period of Hindu rajas the State had the absolute right in the soil, and that the people enjoyed the land only on sufferance. The modern native States are all either the creations of Mohammedans or English and they do not at all represent the genuine Hindu kingdoms.

If we are to place these questions on an historical basis we ought to go to the real history of the country, and not to the period of brigandage and plunder when the British nation came on the scene. That the early British administrators did not pay any attention to the institutions of the country is manifest from their own admissions. The district of Tanjore, the richest in the Madras Presidency, came into the possession of the British in 1798. Before the occupation, a Commission was sent to institute enquiries as to the modes of tenure during the days of Hindu government. The Commissioners reported that they had not been able to obtain any information anterior to the year 1773. Is it not strange that in a district like Tanjore, noted from time immemorial for its opulence, culture, and other well-marked signs of a high state of civilisation, there could be found in 1798 no traces of indigenous institutions beyond 1773? And be it also remembered that it did not pass through many internal revolutions. The fact is that it was not to the interests of the Commissioners to go beyond 1773, *i.e.*, beyond the Mahratta period, as it would be conclusively proved that the State had no such claims as trumped up. The Mahratta system of revenue administration was simply the Mohammedan dictum that the State was the absolute lord of the soil, for the Mahrattas came to Tanjore simply as the representatives of the Mohammedan dynasty. The Mahratta system,

therefore, coincided with the British. That the East India Company committed itself to a definite line of policy without sufficient enquiry into the institutions of the country is is clear from the fight that the Madras Government had with Collector Place, of Chingleput, which ultimately resulted in his dismissal. Mr. Place, the first collector of the Chingleput district, was entrusted with the settlement of that district. As a preliminary, the Government had lain down the following dictum in the settlement of the rights of the villagers:—"It is the first feature in all the governments of India that the sovereign, whether he be a Mussulman or a Hindu, is lord of the soil, and hence it is no alienation of lands from the property of the Circar, or rather, no possession of land whatever is valid without a written instrument from the superior lord, and this distinction has invariably followed the conquest of all the nations who have established themselves in India. As it would be impossible (and it would perhaps be unwise if it was practicable) for the Government to cultivate the whole of its possessions by means of hired labourers, the tillage of the land has by a natural policy fallen to the care of the indigenous inhabitants; hence the division of the crop between the circar and the raiyats, and the proportion which the latter receive, is, in fact, wages on the price of their labour. Though the inhabitants of each village may, from generation to generation, have cultivated the lands adjoining to it, yet the original compact is not changed by residence; they can establish no more rights of inheritance to the soil than tenantry upon an estate in England can establish a right to the land by hereditary residence, although the liberal custom of English landlords has generally given a preference to the ancient inhabitants, where a reasonable rent has been acquiesced in." This oracular deliverance had but little support. The officers that came in actual contact with the conditions of the country pointed out the erroneous assumption of Government. Mr. Ellis, an experienced district officer, thus speaks of the decisions of Government:—"The decision was felt by all acquainted with the subject, notwithstanding the various reasons adduced to support it, to be founded on erroneous principles and subversive of the just rights of the people." Mr. Place, when he came into personal contact with the people, was led to reconsider the whole matter, and admitted that fuller investigation had led him to change his mind. But the Government was firm. Thus the fiction that was invented in 1796 became an accomplished fact by the beginning of this century. The ancient village communes were looked upon as parasites of recent growth, and the frame of mind, according to Professor Adam, of the Madras Government, at that time resembled that adduced by Sir Henry Maine as characteristic of the pre-Benthamite era. "I know," Sir Henry says, "no more striking instance of an historical misconception (although at the time a very natural one) than Hobbes's comparison of privileged corporations and organised local groups to the parasites which the physiology then becoming fashionable had shown to live in the internal membranes of the human body. We now know that, if we are forced to use a physiological illustration, these groups must rather be compared to the primary cells out of which the whole human body has grown up." The whole action of the Government was simply characteristic of a conqueror who often conveniently mistakes might for right; or, as Professor Adam, in his admirable paper on "Chingleput and the Village Community," puts it, "when the basic idea of law was *order*, the *dominium* might well be conceived to lie with the village co-proprietors; when the basic idea of law had become *force*, the *dominium* will naturally pass to the circar. The Governor-in-Council was, therefore, perfectly justified in laying down in 1796 'that the first feature in all the governments of India is that the sovereign is the lord of the soil;' though when he adds that no claim whatever to hereditary possession of land is valid without a written instrument from the superior lord, he exhibited a blissful ignorance of a time when superior lords, in his sense of the word, were as rare as written documents." It has been truly said that a kingdom was lost by the loss of a shoe of the commander's horse. It may be said with equal emphasis that the people of the Madras Presidency lost their communal rights by the misapplication of the word *mirasi*. This word has played an important part in the revenue history of the Madras Presidency since the period of British occupation. It has been the bone of contention between various schools of British administrators. Volumes have been written upon it. Really, it has been the shibboleth on which the village communities have been sacrificed. Some explanation of this word is, therefore, necessary to understand the attitude of Government at the time.

The etymology of the word *mirasi* is still shrouded in obscurity. According to acknowledged authorities, it is of Persian origin, meaning a sort of manorial right over the occupants of the soil; but the word may be traced to a Dravidian origin. The words *meras* and *maniam* occur in ancient deeds as dues for the support of pagodas and tanks. *Mera* may be a contraction of *melvaram*, which is actually the share of a *mirasidar*. The Mohammedan conquerors might have adopted this word and given it a Persian termination. The British Government took a firm hold on the idea of conquest, and maintained that the *mirasi* was a right created and conferred by the Mohammedan conquerors by a sanad or written law, and wherever this sanad or written law did not exist, there was no *mirasi*. The Government did not enquire whether there existed any word corresponding to *mirasi* in the indigenous institutions of the country, nor did it appear to have imagined that the Mohammedans would not be likely, on the one hand, to give a name to something that did not exist, or on the other, to have introduced a new institution without fortifying it by a sanad or written title-deeds. Government appears to have forgotten or ignored the fact that in India the unwritten customary law, and not contract, was the order of the day. There was no difficulty whatever in ascertaining the fact that the *mirasi* was an old tenure. The ancient and time-honoured word *kaniatchi* fully conveyed all the rights and privileges conveyed in the word *mirasi*. All that the Mohammedans did was to transfer the *mirasi* or *kaniatchi* right from some of the original owners to their *protegés*. They did not create this right, They simply robbed Paul to pay Peter. This was the practice followed not only by the Mohammedans, but also by the Hindu Sovereigns when they conquered a new territory, to favour their attendants and courtiers. Thus, in the *mirasi* papers, published by the Madras Government, will be found a grant of the 16th century to one Malla Reddi, who, with certain persons of the Yerra-Yellama caste and their families, came as a settler into the country. This grant appoints all the village officials according to the custom of the commune, and enumerates in great detail their *meras* and *maniams*. Mr. Foulkes, of Salem, an archæologist of great repute, mentions similar grants given by Hindu kings in Salem. These grants, according to Mr. Foulkes, belong to the 9th century. It will thus be seen that the *mirasi* right was not a creation of the Mohammedans on the granting of a *sanad* or title-deed, but of ancient origin, and is only another term which came into popularity during the Mohammedan period for the time-honoured word *kaniatchi*. A *kaniatchi karan* means, literally, a supervisor. It is probable that in the evolution of the village commune the head of the village gradually assumed to himself a manorial right, perhaps backed up by a powerful invader, who found him a fitting tool to deal with the independent villagers. This view is further strengthened by the fact that the learned Father Beschi, the Jesuit priest, whose intimate knowledge of the Tamil language is unquestionable, and who had exceptional facilities for mixing with the people, considers "that the right of the *kaniatchi karan* is one of the hereditary *dominium*, that is, the possession of the whole sum of all the rights over a thing, including all its servitudes, the right of consuming not only the *fructs* but the *corpus*, a right here indicated by the privilege of allowing cultivable land to go waste." There is no reason to doubt the statement of Father Beschi. He was a learned Latin scholar, versed in the intricacies of Roman jurisprudence. He was equally learned in Tamil. He could, therefore, rightly apply the Latin legal terms to their corresponding Tamil terms without committing mistakes, which, unfortunately, was very common with many an English administrator, owing to a want of a correct knowledge of the respective languages. Father Beschi travelled about the 17th century. It is thus clear that the *kaniatchi karan* has gradually assumed a manorial right. Such a view is entirely consistent with the history of village communes in Germany, where the head of the village during the Middle Ages became the lord of the manor, and the free independent peasants became the down-trodden serfs or villeins. The analogy could not be pushed further, for, while in Germany the lord of the manor became the absolute proprietor of the mark to the utter extinction of the rights of the peasants, in Southern India the *mirasidar* or the *kaniatchi karan* became only a predominant partner. The constitution of the village commune was left intact. The reason is not far to seek. From time immemorial in the history of the village commune, certain fees were deducted from the harvested crop before the division amongst the villagers took place. These were

known as *tarapadi manium* and *purdie meras*. The first was for the satisfaction of certain claimed hereditary rights of superior proprietorship, either the king or some chieftain under whose protection the villagers lived. The second, for the remuneration of village officers, the pariah cultivator, and for the maintenance of irrigation works and places of public worship. The word *tarapadi* is a compound word, *tara*, village, *padi* or *padu*, chief—meaning, chief of the village. This word is now more common in Malabar than in Tamil countries. *Tarapad*, or *taravad*, now means a *marum akadayam* family with sufficient landed property and assuming certain importance in the village. But there can be no doubt that it originally meant the chief of the *tara*.

Now to our point. In the Teutonic mark, the lord of the manor swallowed up the rights of the people to the utter annihilation of the commune; in the Dravidian mark of Southern India the *kaniatchi karan* or the *mirasidar* simply stepped into the shoes of the *tarapadi*, ousting him, without disturbing the constitution of the commune. For, it did not matter much to the villagers who claimed the *tarapadi mainam* so long as the rights were respected. The claimant may be a wrongful one, but that does not weaken the claim which is an immemorial one. The grant to Mallu Reddi by a Hindu Sovereign mentioned above, is a case in point. The grant conferred on him the *kaniatchi* or *mirasi* right, but it also laid down distinctly the rights of the villagers. Malla Reddi has simply ousted a *tarapadi* and appropriated to himself the *tarapadi's* share. When the Mohammedan conquerors came they found a system quite suited to their requirements in perfect order. They created their *mirasidars* without disturbing the *status quo*. There are, therefore, no grounds to suppose that the *mirasi* was a right created by the Mohammedans under the protection of a *sanad* or title-deed, with absolute sovereignty of the soil, ignoring the claims of the villagers, and that in the absence of any such *sanad* or title-deed the villagers should be considered simply as occupiers of the soil so long as they till it and give the Government dues. That the Mohammedans simply adapted themselves to the existing conditions has been fully borne out by Colonel Fullarton, who commanded the Southern Army on the coast of Coromandel during the operations of 1732-33-34; and in his, "A View of the English Interests in India," he thus speaks :—"The wisdom of the Moorish conquerors of Indostan failed not to preserve this ancient fabric of Indian adoration. In fact the Mohammedan Governments apparently reverence the rites of the Gentoos, who still constitute the mass subjects in the peninsula. Under the Moors they are liable to oppressions incident to all arbitrary Governments, yet their tyrants have mingled policy with force, and as the Goths adopted the manners of these nations whom they conquered, so the Mussulmans have assimilated with the customs of their Indian subjects." I believe I have given sufficient evidence for a short paper like this to prove that the people of Southern India had, from time immemorial, an inalienable right on the soil they tilled, that they maintained this right through all the changes that had taken place in the history of India till the advent of the British, and that the village communes they prized so much were shattered to pieces only after the tremendous blows they received from the early British administrators, ignorant of the past history and genius of the people, which built up a system of institutions of surpassing vitality which, in the words of Professor John Adam, "Tacitus viewed with wonder among the Germans, and Auveiyar extolled among the Tamils; which Mahmud of Gazni found flourishing in Hindustan, and Mohammad Shah, nearly eight centuries later, left behind him unimpared; which the Saxon bore with him to Britain in his galleys, and the Pilgrim Fathers carried to New England in the *Mayflower*."

The first blow dealt to the commune was the revenue settlement with individual holders of land, and the liability of his land being sold for arrears of revenue, for court decrees, &c.; the second was the management of irrigation works directly under Government control; the third and last was the appropriation of village wastes or "poramboke" lands for forest conservancy. The question may be asked: Is it possible to go back to the old system? I unhesitatingly answer, No. The conditions are so completely altered and the system of administration so rigidly crystallised that no statesman would dare revolutionise the present system. But every candid observer must admit that there are several lines on which reform might be effected so as to bring relief to the rural population. But no reforms are possible unless Government recognises the fact that the people—I mean the rural people—are not "the dumb, driven cattle" they are represented to be, but a highly-organised intelligent community, capable of looking after

their own interest. When once this is recognised, reform is easy.

As this paper would not be complete without giving a bare outline of my views regarding the utilisation of communal organisation for the improvement of agriculture, I lay them before you so that your matured experience may enable me to study the question from all points of vantage. I mentioned three blows that paralysed the village commune: 1st, the revenue settlement; 2nd, the irrigation policy; 3rd, the forest conservancy. I cannot deal with the first, for I do not know how to interfere with it without touching the finances of the country. The second is not so difficult. Some changes might be effected with advantage to the people and gain to Government. The irrigation works are divided into two main branches, the "major" and the "minor." I would not at all interfere with the "major" system, which ought to be under the direct control of Government. I do not see any reason why the "minor" system should not be handed over to the people. The "minor" irrigation system comprises mostly rain-fed tanks, and rarely river-fed, each tank irrigating not more than 100 acres. They are for the most part under the direct control of the district collector, which means that the tahsildar, with his staff of tank supervisors, has the real control. The already over-burdened tahsildar scarcely finds time to look after the irrigation works, which, therefore, pass into the hands of low-paid officials and incompetent contractors. The result is that the tanks are often not repaired in season, and when the distracted villagers appeal to the *taluq* officials for remedy, no remedy is forthcoming. The tahsildar could not condemn the supervisor or the contractor, for that means a condemnation of himself, as he is in charge of these irrigation works. The fight comes during the *jamabandi* time, when the divisional officer receives petition for remission for failure of crops for want of water. Against the poor villagers are arraigned the whole staff of the underlings of the Revenue Department, from the revenue inspector to the village accountant, denying the statement of the villagers, and we can more or less guess who succeeds in this encounter. The result often is misery to the villagers and loss of revenue to the Government. That I am not drawing on my imagination can be easily proved by the fact that in the district of Chingleput alone annually something like 25,000 acres of land, classed as "wet," go without cultivation. This, at the low figure of Rs. 4 per acre, including water cess, means a lac of rupees. And be it also noted that this does not give us any idea of the extent of partial remission granted through failure of crops. I do not for a moment say that the whole of this vast area is left uncultivated through bad repair of tanks. Seasons have a great deal to do with it; but there is no denying the fact that the whole system of "minor" irrigation works, on which over two million acres in the Madras Presidency depend for irrigation, is far from satisfactory. Government is fully alive to this fact, but no remedy has been suggested. My plan is very simple, and if honestly carried out is likely to meet with success. At any rate, an experiment might be tried. The plan is to make the villagers the executive authority, and the tahsildar judicial, instead of the tahsildar as at present combining in himself both the executive and judicial functions regarding irrigation matters. The first step towards this reform should be the organisation of a Village Irrigation Board, consisting of a certain number of members, according to the size of the village. The members must be those who have a stake in the village, and may be nominated by the collector on the recommendation of the tahsildar. The collection of the water cess must be entirely left to the Board. The tahsildar must have full power to receive and deal with all complaints from the villagers against the Board. The immediate result would be the disappearance of the hated contractor, and the dawning of self-help amongst the villagers. It goes without saying that the repairs will be done in time, for the members of the Board, unlike the tahsildar and his staff, who draw fat Government salaries, will be the first to suffer. Then work will be given to the poorer inhabitants of the village. Ultimately a reduction in the water cess might be effected through economy in the management. For works requiring professional skill, which will be few, the services of the District Board Engineers might be utilised. I have been told by a tahsildar friend of mine that he has often entrusted the repair of tanks to the villagers, and he says that the work was invariably done to his entire satisfaction. In fact, I owe to this gentleman this idea of resuscitating the old village *panchayats* and entrusting them with the management of minor irrigation works.

The third blow dealt was the conserving of waste or "poramboke" lands under the Forest

Department. I should be the last to cry down forest conservancy. The Forest Department has done immense good, and is destined to do still more good in the future. But it cannot be denied that with the characteristic enthusiasm of a newly-created department to extend its jurisdiction it has done a great deal of harm to the agricultural population. This subject has been ably discussed by Dr. Voelcker in his admirable report on the improvement of Indian agriculture, and forms the basis of an elaborate resolution by the Government of India, Department of Revenue and Agriculture, circular No. 22 F, dated the 19th October, 1894. The resolution has been framed in a bold and statesmanlike spirit, evincing the utmost sympathy for the agricultural population, and fully identifying the interest of the State with that of the people. But the most interesting portion of the resolution is that which deals with the question of reviving the old communal spirit by which the villagers might be made able to look after their own interest in the matter of fuel and fodder reserves.

The forests of India, being State property, may be broadly divided into four classes:—(*a*) Forests the preservation of which is essential on climatic or physical grounds; (*b*) forests which afford a supply of valuable timbers for commercial purposes; (*c*) minor forests; (*d*) pasture lands. The first two do not concern us. It is with the last two that the villagers have a great deal to do. Class 3 comes under what Dr. Voelcker calls the fuel reserve, which are not forests in the true sense, but which grow abundant inferior trees for fuel and for building ordinary farm buildings, tools and other farm implements. Dr. Voelcker has shown with all the scientific skill and eloquence at his command, that the great danger to Indian agriculture is the increased consumption of cattle-dung as fuel, consequent on the scarcity of fuel in many rural parts. It is, therefore, highly desirable that the supplies of fuel to the villagers should be developed so as to divert the dung to its legitimate use, and the facility for obtaining the fuel increased. There are conditions laid down in the forest code for the sale of fuel to the villagers, but, the department being a centralised one, it is a far cry from the village to the head office of the district. My suggestion is that this class of forests should be entirely left to the management of *taluq* Board, which has proper representatives of the people in it. The district forest officer should have a supervision, so as to give his professional opinion on the reserving of trees, &c. As to the rest, the Board is better fitted to look after the interests of the people. No doubt the Forest Department will fight for its rights, for this branch of its work is sure to be a profitable one in the future, as the cost of maintenance is practically very little. But the Government should certainly subordinate the prestige of a Department to the vital interests of the people. The only source of manure, cattle-dung, is now burnt for want of wood fuel, and in the opinion of the most eminent agricultural chemist the danger is a very threatening one. The last class of forests is one which is of the utmost importance to the rural population. I cannot do better than to quote from the Government of India Report mentioned above, regarding these:—"The fourth class of forests referred to are pastures and grazing grounds proper, which are usually forests only in name. It is often convenient, indeed, to declare them forests under the Act, in order to obtain a statutory settlement of the rights which the states, on the one hand, and private individuals or communities on the other possess over them. But it by no means follows as a matter of course that these lands should be subjected to any strict system of conservatism, or that they should be placed under the management of the Forest Department. The question of agency is purely one of economy and expediency, and the Government of India believe that in some cases where these lands are managed by the Forest Department the expenditure exceeds the revenue . . . . The Government of India are clearly of opinion that the intermixture of plots of Government land, which are used for grazing only, but upon which trespass is forbidden, with the cultivation of occupancy and proprietary holders, is apt to lead to extreme abuses, and especially so where these plots are under the management of the Forest Department. The inferior subordinates of the Forest Department are, perhaps, as reliable as can be expected on the pay which we can afford to give, but their morality is no higher than that of the uneducated classes from which they are drawn, while the enormous areas over which they are scattered, and the small number of the controlling staff render effective supervision most difficult." The final conclusion arrived at by the Government of India is that "it will generally be possible to lease or otherwise manage the unoccupied lands of a

village through the agency of the community." To this liberal declaration I have nothing to add. I fully trust that the local governments and the responsible district officers will loyally carry out the intentions of the India Government.

I have attempted to prove that the village communities of Southern India were of very ancient origin, that they formed a bulwark against foreign aggression, that they received tremendous shocks and withstood the ordeal which showed their internal strength, and that they have left behind indelible marks, which show that though they have been torn asunder, the key-stone is unimpaired; and that the sacred duty of a benign government is not to tear this last vestige but to build up the citadel of village autonomy round this key-stone. The genius of Lord Mayo realised this fact and gave to the people of India the blessings of a municipal government. Lord Ripon improved upon it, and we have now an admirable system of local government in municipal matters from the big corporation of Bombay down to a union. Here and there cases of failure occur, but in reviewing the whole municipal administration of India, the Government of India has only praise to bestow. Will it be too much to ask the Goverment to extend the system to the villages where co-operation stands in greater need in certain respects than in the cities, and where the germ of local self-government had first seen the light in India ?

DISCUSSION.

Mr. J. B. Pennington said he was very pleased as an old collector of Tanjore to hear what was said about that part of India by the reader of the paper. He sympathised with much that the author said about the sharing system, and thought it the best form of Socialism we had any example of. But even in Tanjore, labour did not get quite its fair share. Everybody else took care of himself pretty well, but the actual cultivator who did all the work by no means got his fair share of the produce, and was, in Tanjore, practically in a state of serfdom not very far removed from slavery.

Mr. R. Sewell said that the subject was naturally of great interest to anyone who had been in charge of an Indian district or had laboured amongst these communities. It was going too far to say that the British authorities had always been actuated by strong motives of self-interest in governing the country. On the contrary, they had always tried to do their best for it and for the people, though no doubt mistakes had been made. The course originally adopted with regard to Mirasi rights was a mistake; but this had not been carried into effect, and the rights in question had been fully recognised and upheld in practice. The Government had been *bonâ fide* misled, partly by the laws of Manu, which asserts royal ownership of the soil, and partly by the ignorance of their native advisers, who could give no account of the true origin or antiquity of the custom. People could not understand the present condition of India and its institutions unless they studied the records left to us from former times, since there was nothing else left on which to base an opinion. Without some knowledge of facts, mere assertions as to what took place 500 years ago were valueless. It was, therefore, necessary to study the past history of the country, and it would be well if every Hindu, gentleman or peasant, could learn that history. We were laying the foundation of great political difficulty and danger in India by neglecting to teach the people the condition of the country before the British came there. They have themselves no knowledge or recollection, and eagerly swallow the wild and reckless statements of irresponsible agitators. The result is a rooted belief in English perfidy. They do not understand that England saved the Indians. The inscriptions on the temples in Southern India, if properly studied, were an excellent record of the former rights of the people in the land. The inscriptions on the Tanjore temples unmistakeably showed that the land was not only clearly recognised to be the property of the ryots of the village communities in body assembled, but that even if the sovereign wished to make a grant of land tax-free, he had to purchase it from the community. Many records existed of such grants in Tanjore, between the years 1000 and 1100, and many have been carefully translated by Dr. Hultzsch. Complaints were often made of British taxation. Now we have only imposed a very light land tax; far lighter than that which we found on our arrival. The taxation under old native rule was oppressive. The Tanjore temple inscriptions of the year 1118 shewed that the first tax imposed on the villages was for revenue; then came the tax in money, whatever that might be. These two may be set off as against all of ours. Then there were three taxes of which there was no translation; other taxes were for officials; on fruit; on looms; on oil-mills; and another on trade generally—a very wide term. At present, if a ryot dug a watercourse or made a tank, he received the full benefit from it; but in those days he was promptly taxed for having done the work. Taxes were also imposed on weights and measures; on drugs which had gone bad in the bazaar; on shops; on salt; on elephants' and horses' stables. Considering how taxes were collected in India in old days, a pretty good idea could be formed from this of the state of things formerly existing. Many officers agreed that it was well, as far as possible, to maintain the old village

system. But the great difficulty was, that while in theory nothing could be better or wiser than to give the management of a village to its own headmen, in practice dependence could not be placed on the characters of individuals. Their quarrels among themselves had in numberless villages resulted in the most terrible condition of affairs imaginable, producing a perfect chaos. In an Indian "faction village"—a term well known to all district officials —the headmen and principal ryots took sides and banded together to murder, forge, bring false accusations, and do everything they could to ruin one another. Instead of being rulers and leaders of thought in the villages, they gave themselves up to a sort of Corsican vendetta, producing a state of things which could only be described as anarchy. It was absolutely necessary to protect the individual villagers against such a state of things and, whereas previously inhabitants of villages were at the mercy of their headmen, under British rule every man can go for justice to the British officers. Moreover, it was an utter mistake to say that the English had abolished these village communities. So far from this being the case, the village community formed, as a fact, the fundamental basis of the whole of our administration at the present day. The reader of the paper complained that the villagers were not allowed to manage their own water distribution. That was another utter mistake on his part. They did so in every instance, except in the case of the larger Government irrigation works, where, of course, more careful control was necessary to prevent waste of water, but with all village tanks and watercourses the village *nirkanti*, paid from village revenue, distributed the water for each field according to immemorial custom in the village. A great deal more could be said in answer to the criticism of Mr. Menon on British administration, but it was necessary beforehand to know what he was going to say or to postpone reply till after publication of his paper.

Mr. C. L. Tupper said the question was, whether the community system, originating in times of internecine tribal warfare, could continue to exist in the same form under the *pax Britannica*? We had tried to support the institution in Northern India, and our laws and courts of justice had introduced the idea of individual rights; but the question was, whether the village community in its old form could co-exist with the notion of individual right? The quarrels among the village headmen were but the assertion of individual right; and it was that which made the survival of the village community, in its old pristine form, impossible under our rule. Much might be done by encouraging co-operation, though it might be impossible to prop up an institution which was doomed to alter in its conditions as time went on. The suggestion at the end of the paper was valuable; and in parts of India the local and municipal bodies were beginning to carry out an administration somewhat on the old lines. The statement of the reader of the paper that the modern native States were not at all representative of the ancient Hindu kingdoms was very far from the fact. The whole of the western country to the north of the Bombay Presidency was at one time under Rajput rule, though it had been split up—in one direction by the Sikhs, and in the other by the Mahrattas. Here, in the old Rajput principalities, as in many other parts, as Sir Charles Metcalfe had said, the village communities had survived dynasty after dynasty.

The Chairman said it having been his fortune to administer justice in both North and South India, he had had the opportunity of studying the most interesting land law in the world, because while there was to be found there almost every variety of tenure, from the most ancient to the most modern, certain rights of the State, and of the classes connected with the soil, had been recognised from time immemorial, with a degree of uniformity which was remarkable in view of the extent of the area of the country, and the circumstances of its history. Of whatever other errors it may have been guilty, there could not be attributed to the British Government selfishness in its views of land - ownership in India. The Bengal Regulation to which exception had been taken was an attempt not to claim for the Government ownership of the land, but to find some persons whom it could recognise as the landowners. True, in giving effect to that intention, the Government had made mistakes, and had, in some instances, conferred the landlordship on persons who were mere collectors of the revenue, while it omitted to provide adequately for the protection of the rights of the cultivating classes; but on discovering its mistakes, the Government had done its best to rectify them, and in the settlements of the North-Western Provinces it was careful to recognise the rights of all classes in the land. Information as to what those rights were, and how they should be protected, would be found in a work published by Mr. Thomason, who was afterwards Lieutenant-Governor of the North-West Provinces. In the Punjab settlements even greater regard was paid to ascertaining local customs. In Southern India, the State pursued a somewhat different course to that which was adopted in the North. Whereas, in the North, village communities were recognised wherever sufficient trace of them could be found, in Southern India proprietary right in land, when enjoyed by the cultivating classes, had in many districts ceased to possess any value, and had practically disappeared. Consequently, in an early Regulation (xxxi.), of 1802, the Government claimed to have reserved to itself, and to exercise the actual proprietary right in lands of every description. Nevertheless, it proceeded to make a permanent settlement of the land revenue with some of the larger zemindars, with some though inadequate provision for the protection of the tenants. It also attempted to effect settlements with village proprietors by a system of village leases.

This system failed, because in some cases the communities had disappeared, and the ryots severally were unwilling to undertake a joint responsibility, or because, where the community existed, the revenue had been assessed at rates for which it would have been disastrous to engage. Eventually, what is known as the raiyatwari settlement was introduced. In this system each plot of land is surveyed and assessed at a certain rate for a term of years. A raiyat may retain it in perpetuity if he pays the assessed rates, or he may abandon it without being further liable for the revenue if, at the commencement of the agricultural year, he informs the revenue officer of his desire to curtail the area of his holding. He agreed with the reader of the paper that the introduction of this system had resulted in the further destruction of village communities. It had also injured the rights of a certain class of tenants holding land under village proprietors. By what he might term the common law of India, any man occupying waste, and rendering it fertile, was entitled to hold it, subject to the obligation of paying revenue for it to the State. Early Indian history, as far as it could be gathered, showed the meaning of the due which the Raja received. It existed in Malabar before the conquest of that country by Hyder. It was there levied only on the occasions when the Rajas were called on to repel an invader, and was called the protection rate. According to Manu it was the consideration for the protection which the Raja afforded. Mr. Baden-Powell's valuable work on Indian land tenures contained evidence that even before the Aryans went to India a village system existed. The Kols are supposed to be the earliest people who formed village communities. The chief and the village head man received gifts of grain. Under the Dravidians the village bands were divided into lots, of which one was called the king's share, or royal farm, and other portions were assigned to the priest and head man. That continued for a time, but subsequently the king took a share of the produce from every field, except the priest's and the headman's. In his experience he had seen many varieties of the village system, but had never met with one fulfilling exactly the conditions mentioned in the paper. He had frequently found villages held in common, but never a village cultivated in common, and the produce shared in common, unless it was held by a single undivided family; and though such conditions might possibly exist in India, they were hardly consistent with the Aryan law which was based on the family. Mr. Baden Powell warned us, that in speaking of village "communities," we ought not to imply anything like a socialistic or communistic right or interest. The earliest form of joint - holding with which he was personally acquainted he had found in the Rohilcund district. In 1871-2 it had to be decided in the High Court of the North - Western Provinces who were the proprietors and entitled to the settlement of a village on the borders of the Punjab, the questio having been raised originally at the beginning of the century. The earliest record of the village history showed that all who lived on the village site were of the same tribe, and held the land in common. Any man possessing three ploughs ploughed a three-plough share, a two-plough man had a two-plough share, and so on, the shares varying in each year. The lands were sufficient for all: hence the question of individual right never arose. There was a Hindu over-lord, but all he did was to afford the villagers nominal protection, and when the Rohillas came this chief was driven away. On the expulsion of the Rohillas the British Government leased the village to a Pathan revenue collector. The Pathan having but a temporary interest in the estate, did all he could to screw profit out of the villagers, and in the result they were almost ruined. The Government thereupon turned out the Pathan and leased the village to the old over-lord, but with no better results; and ultimately the Government gave the lease to the village proprietors. The community then became very prosperous. At the first settlement for thirty years the over-lord asserted his claim as proprietor, and the revenue engagement was taken from him. The villagers appealed from the Board of Revenue to the Lieutenant-Governor, Mr. Edmonson, and they were held to have made out a good *prima facie* case which required looking into. Their right was reserved, and the question whether or not they were proprietors was eveutually decided in their favour. That was an instance where there were no shares in the land; but the most common form of joint village was where there were several proprietors each holding their own lands and having the waste lands in common, in anna shares, or else in proportion to their cultivated land. The great advantage which it appeared to him village settlements possessed over raiyatwari was that they generally secured to the village proprietors more or less waste land. Under the raiyatwari system, waste was presumed to belong to the Government. The raiyatwari system allowed each small cultivator to deal directly with the Government, taking each year as much land as he wished or giving up what he did not require, and being responsible only for the revenues assessed on the plots held by him. That was a great advantage; but when that system was applied to the Mirasi tenure in Southern India, complications arose. The Mirasidars claimed rights over the waste lands just as in the North-West and the Punjab. And there was originally the same customary law both in the north and in the south of India with regard to the tenants of village communities. According to the common law of India, the Maurasi tenants—the tenants permanently settled in the village—were entitled to rights of occupancy so long as they paid the customary dues. Another class of tenants came from the neighbourhood to cultivate land in the village and frequently paid rent at lower rates, because they generally held inferior lands, and had no rights of occupancy. Under the rayatwari system the Maurasi

tenants were reduced to the position of ordinary cultivators. The Rent Bill now being introduced in Madras would doubtless possess one of the features of the Act which had been passed for Bengal. The Bengal Rent Act was designed to keep alive and preserve every one of the various rights in the land still found in existence there. With regard to village tanks, a Commisssion sat in 1870, to ascertain in what manner provision could be best made for their repair. Originally this was executed by the people themselves, under the supervision of the collectors. These officers were compelled to insist upon repairs being effected a little more thoroughly and rapidly than was the practice, and to enforce performance of the duties owed by the villagers to themselves and to their neighbours. This resulted in a system of forced labour, with the ovious objections to that system. As a remedy, a money contribution was levied in lieu of labour, and the repairs of village tanks were entrusted to the Public Works Department; but the staff was not sufficient to look after them, and the duty of supervising repairs again devolved on the collectors. Of late, the Madras Government had been considering schemes to obtain the co-operation of the villagers, and to induce them of their own accord to furnish the necessary labour. Probably, no better scheme could be divised than that which had been advocated by Mr. Menon. The Forest Department had been established not so much with the object of securing an additional source of revenue, but to improve the irrigation of the land. Many officers, educated at Cooper's-hill College, were now employed in that Department, and showed great intelligence and ability in the performance of their duties. Desiring to obtain the best scientific opinion on the agricultural condition of the country, the Government commissioned Dr. Voelcker to inspect and report on it. Dr. Voelcker had discharged this duty in a manner which was to be anticipated from his reputation. One result of the recommendations made by him had been the promulgation of an order which made the benefit of the inhabitants of a locality the first consideration in forest management. He ventured to think that the promulgation of this order, which secured to the cultivators of lands contiguous to forest tracts privileges which had hitherto been somewhat disregarded, or advantages of which they stood greatly in need, would be an enduring testimony to the desire of Lord Elgin's Government to consult the best interests of the people of India.

Dr. J. A. VOELCKER said that undoubtedly there existed remains of the old system of village communities, as, for example, where the village carpenter and potter received their wages in grain. The tendency of English rule had, however, been, on the whole, to break up village communities rather than to preserve them. The difficulty now was to separate what was good from what was bad. Reviewing the whole subject, he thought that not much would be gained by leaving the village communities to act for themselves, unguided by English authority over them. If the principal men in the villages could be properly guided, no doubt great advantages would result, but they certainly needed guidance. As to improvement in agriculture, looking at the village wastes and barren hills, one could not but feel that without a guiding hand land would still remain waste, and hills would produce nothing. In dealing with this subject it should be remembered that we had not now to deal with the old-time conditions. We had done our best to prevent famines, and had accordingly to provide for increased populations. The present conditions were now altogether different, and the village community system was not able to cope with the altered circumstances. The irrigation works of the past were certainly worthy of great admiration, but the impression forced upon him was that a great deal more in the way of irrigation work might be done by the villagers. Wastes were allowed to remain valueless and hills were unplanted which, under the enlightened rule of the Forest Department, might be utilised. After all had been said, he thought that whatever was to be done in the future would come rather out of the experience derived from the failures of the past. There was certainly room for improvement in regard to irrigation works and repairs. The Government routine was very troublesome in its details, and whenever a slight repair was required to a village tank, a complicated procedure had to be gone through, and before the right person could be got hold of a great deal of damage might be done. Again, in the afforestation of land bordering on tanks, the trees planted should become the property of the people, and not be allowed to be put up to auction and sold to the highest bidder. He did not think that any good could be expected to come out of the village community system alone, but a feeling of self-help might be inculcated, and in that way good might result in the future from the knowledge of what had been done in the past. The administration of village communities could not be left to the villagers themselves. Experience in the past had shown the immense disadvantage and loss arising from want of combination for the common benefit, and efforts should be made to induce the villagers to act together for the common benefit in carrying out necessary works. He wished to express his appreciation of Sir Charles Turner's kind reference to the work he had done in India, and, in conclusion, mentioned the pleasure it gave him to again meet the reader of the paper, who occupied a responsible place in the Sydapet College, as a teacher of agriculture. It was Mr. Krishna Menon's desire to make himself more useful to the service of Indian agriculture that induced him to undertake—at his own expense—his present visit to this country, and for this as well as for the able paper which he had just read, he deserved very great credit.

Mr. KRISHNA MENON, in reply, repudiated

having said anything of selfishness or self-aggrandisement being the motive of the English Government. He had only said that British administrators, acting with good motives, had made mistakes from want of knowledge of the history of the country. They had simply followed Mohammedan example. As a servant of her Majesty, he was well aware of the happiness and prosperity conferred upon India by the British rule. Being connected with the Agricultural Department, he had had exceptional opportunities of knowing the improved agricultural condition of his own province. His object was not to find fault with the British Government, but to point out certain lines on which reforms might be carried out. It was impossible to revive the village communities under the present altered conditions, but he thought his suggestions might be carried out, having regard to the genius and past history of the people. It had been said that the people fought and cut one-another's throats, so that the Government had found it impossible to go on. That must be a great mistake, for if they were cut-throats and murderers how was it that they had been able to establish these grand institutions? No doubt they told lies in the Courts, as British officials complained; but the fault lay in the defective state of the law. It should not be forgotten in speaking of irrigation works and repairs that a water cess was imposed on the land in addition to what was called the wet tax. For the disturbances spoken of there were many causes. If village irrigation was reorganised and placed on a different footing, the people would be only too glad to look after the repairs. It was to their interest to do so, not only as payers of revenue, but as being entirely dependent on agriculture; more liberty should be given to the people. The minor irrigation works were kept in admirable order. The very fact that they had existed so long, showed that the people were able to work in common, and that they had co-operated to manage and keep up their tanks. If that were the case, it was difficult to understand why they should now be cutting each other's throats. That was not the nature of the people; it was the law that was defective. If the law were made more elastic, and if more chances were given to the people, they would work together. Knowing something of the life of the people, he could say that their standard of morality would compare favourably with that of any peasantry in the world. They were by no means of the type and stamp spoken of. They did not drink—their wages would not permit it. Where the operation of the law was found not to be equal, and where the poor believed that the rich had always the upper hand, they felt impelled sometimes to take the law into their own hands. But that was not a characteristic of the Indian people, who were naturally peaceable. No doubt more taxes had been levied under the Mohammedans, but the taxation was very heavy now. Formerly, in Malabar and Travancore, the system of administration was very different from what it was now; but in Southern India, even to this day, co-operation was practiced. Where the soil was very stiff, a heavy plough weighing 800 lbs. or 900 lbs., and requiring 8 or 10 pairs of cattle to drive, such lands were ploughed only once in two years. The villagers joined in putting their cattle to the plough, and one man's land would be ploughed this year, and his neighbour's the next, so that the labour applied was communal. Where village customs were elastic, and before they became law, men were not so ready to quarrel, as might be the case under other circumstances.

The CHAIRMAN then proposed a vote of thanks to Mr. Menon, which was carried unanimously.

Mr. A. ROGERS writes:—In Mr. Krishna Menon's paper the very existence of such communities, and their communal management of village affairs, were clearly enough shown, and an attempt was made, in my opinion not very successfully, to show that the management of at all events matters connected with irrigation in which more than one village was concerned, was entrusted to a council composed of members of several communities. However this may be, my present object is not that of antiquarian research, to ascertain the real state of affairs existing in by-gone days, or the way in which this communal system has, according to Mr. Menon's account, been broken down under British administration, but to discuss how far a practical reversion to the old system in irrigational and forest conservancy matters, as proposed by him, can be carried out with advantage to the State and the villages themselves. Before entering on this subject, however, I would note briefly how utterly subversive of improvement in the agriculture of the country, either by the communities in general or individuals in particular, must have been the system he describes of occasional redistribution by lot of village lands among those entitled to share and cultivate them. Would any individual or body of shareholders think of expending labour and capital on the improvement of land thus temporarily brought into his or their occupation, when it was certain that the benefit of such improvement would in the course of a few years, at most, be handed over to some one else? To hope for anything else would be to look for altruism *in excelsis* in a practical and selfish world. But to return to Mr. Menon's paper. He notes as three blows that paralysed the village communes: (1) the revenue settlement; (2) the irrigation policy; (3) the forest conservancy. With the first of these he says he cannot deal, because he does not know how to interfere with it without touching the finances of the country. But I cannot pass this point over without a word in its favour, in all parts of India, to the effect that however imperfectly its functions have been carried out (notably in Madras, as I have officially proved to the Secretary of State) as far as

assessment of the land is concerned, there can be no question of the enormous benefits it has conferred on all classes by the ascertaining and recording in various ways, for the use both of the present and future generations, the actual rights of property in the soil, instead of leaving these to be ascertained, when disputed, by means of reference to village or district officers or unwritten customs or tradition. Such records, I maintain, are the first and indispensable step on the road of improvement, and however much agitators, paid or otherwise, may declaim against such settlements, as lately, in the case of Behar, I am convinced that if we could get at those really personally concerned—the peasantry themselves—we should find the records of rights hailed as the palladium of their individual liberties. Irrigation works are divided into two main branches, the "major" and the "minor." The former of these, Mr. Menon admits, should be under the control of Government; but he would have the latter handed over to the people. They comprise, mostly, rain-fed tanks; each tank irrigating not more than 100 acres. These being under the direct control of the District Collectors, and, subordinately to them, to the *tahsildars* or Revenue Officers of sub-divisions, their repairs are handed over to contractors, and the result is said to be that tanks are often not repaired in season, and when the distracted villagers appeal to the *taluq* officials for a remedy, no remedy is forthcoming, as the latter cannot find fault with the contractors, who are, as it were, a part of themselves. But Mr. Menon may be asked, are there not the collectors themselves, or their assistants or deputies in revenue-charge of *talukas*, to whom a further appeal would be made if the *tahsildars* did not do their duty? I can answer for it that, in case of a complaint of this kind in the Bombay Presidency, it would not be long before an assistant would be on the spot to investigate matters in person or the *tahsildar*, would be ordered to see to the repairs himself. The result, as no doubt it would be if matters were allowed to be conducted in so slovenly a manner, is often misery to the villagers and loss of revenue to the Government. It is then stated that in the district of Chingleput alone annually something like 25,000 acres of land classed as "wet" go without cultivation, which at the low figure of Rs. 4 an acre means the loss of a lac of rupees to the State, although Mr. Menon will not go so far as to say that this is due entirely to bad repair of tanks. It is not improbable that one of the chief causes is unequal or faulty assessment of the lands themselves, as well as the uncertainty of the seasons. The remedy suggested is the organisation of a village irrigation board, varying in number with the size of each village, in whose hands the collection of the water cess and the carrying out of tank repairs should be left, under the general supervision of the *tahsildar*. Then it goes without saying that the repairs will be given to the poorer inhabitants of the village. Mr. Menon has been told by a *tahsildar* friend that he had often entrusted the repair of tanks to the villagers, and the work was invariably done to his entire satisfaction. Is this friend of his such a *rara avis* among *tahsildars* that this plan cannot generally be resorted to, or would not a simple circular order from the collector that outside contractors are not to be employed as long as the villagers themselves agree to do the work, have the desired effect? Village irrigation boards to whom the collection of the water cess should be entrusted apart from the ordinary village revenue authorities would be objectionable as creating a kind of *imperium in imperio*, and necessitating the keeping of accounts of a complicated nature relating to very small sums of money due by individual landholders, whereas the regular authorities would collect the cess and credit it in these individuals' ordinary accounts with the State, together with other revenue demands. To hand over the collection of the cess to such a Board would also necessitate the passing of new laws giving the Board power to levy by distraint and sale of property, &c. On the whole, I think matters had better be left as they are, with the exception noted above, and the Revenue Board should see that collectors and their assistants do their duty in having tank repairs carried out efficiently and in due season. The third blow was the conserving of waste (*paramboke*) lands under the Forest Department. It cannot be—and if it is, it should not be—that the entire waste lands of villages are handed over to that Department to be managed, to the exclusion of the authority of the collector and the ordinary revenue officers. At all events, the conservators of forests and their subordinates are but the collectors' assistants in forest matters, and it is the duty of the collectors to see that the rights of the villagers in pasture, in lands set apart for fuel for their use, and in those required for the extension of cultivation, are not infringed, in the spirit of the resolution of the Government of India quoted. I see no necessity for the organisation of a village board for such purposes. It would lead, as Mr. Sewell, one of the speakers on the occasion of the reading of the paper remarked, to the exercise of petty jealousy on the part of the members against each other on their humbler neighbours, and should be quite unnecessary if the assistant collectors move constantly about their *talukas*, and are open to receive complaints from all classes on all matters in which the latter may consider themselves aggrieved, as they should be.

ELEVENTH ORDINARY MEETING.

Wednesday, Feb. 20, 1895; ALEXANDER SIEMENS, Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bemrose, Henry H., J.P., Lonsdale-hill, Derby.
Roberts, William, 13, Craven-hill-gardens, W.

Watson, Frederick Howard, M.A., 16, Kensington-road, Douglas, Isle of Man.

The following candidates were balloted for and duly elected members of the Society:—

Bagnold, Major Arthur Henry, R.E., Brompton Barracks, Chatham.
Budden, Edward Russell, Camelot, Netherhall-terrace, South Hampstead, N.W.
De Salis, Henry Rodolph, Fairacres, Oxford.
Fielding, P. J. D., 8, St. Joseph's-place, Cork.
Jones, Alfred L., 14, Castle-street, Liverpool.
Porter, Horatio, M.A., 16, Russell-square, W.C.

The paper read was—

THE RULE OF THE ROAD AT SEA.

By Admiral P. H. Colomb.

I.—Why, and under what Conditions, is a Rule of the Road required at Sea?

We require to be fundamentally clear on most of the questions underlying the present and proposed conditions of the rule of the road at sea, and on none more so than on the question of why, and under what circumstances, such a rule is required.

We have ships in the open sea steering in all sorts of directions, and crossing one another's paths at all angles. We have ships in rivers and other narrow channels passing in opposite directions. With vehicles in London we have just the same conditions at such points as the Mansion House and Trafalgar-square, or, in a less complete parallelism, wherever streets cross. In the streets themselves, we have, for vehicles, conditions analogous to those for ships in rivers and narrow channels.

At the crossings, vehicles have no rule of the road as amongst themselves, but it is found constantly necessary to make a policeman represent such a rule. It is evident that no rule could be established here, as there must be continual changes in the right of way. The policeman furthers the traffic by allowing the stream to flow one way for a time, and then stops it and allows the other stream to flow.

In the streets, again, there is not really a rule of the road as between vehicles. The rule is that the vehicle must keep on its own side of the street whether another vehicle is in sight or not, which may be understood by considering the rule in turning corners. But though as between vehicles there is no rule either at crossings or in the streets, drivers have conventional and customary signals amongst themselves which are expressive of an intention. Where there is no policeman at a crossing you see traffic regulated in this way, as you see in the streets the driver of one vehicle giving notice to others behind him when he expects to have to check his rate or to stop. But most particularly do we see this use of conventional signals in the street, when the driver desires to break the rule of the road and cross to the wrong side of the street on necessary occasions.

It is quite clear that, whether in stationing policemen where there is cross traffic, or establishing a right and wrong side of the street, or permitting the breakage of this law after conventional signals expressing the intention to break it, the aim is to conduct the traffic at the greatest speed possible, and at a minimum of danger of collision.

We may safely say that this ought to be the aim of all regulation of traffic on the water, whether in the open sea or in rivers and narrow channels. If, while we are properly developing the higher speeds at sea, we introduce traffic regulations which tend to make the high speed a crime, we are doing something anomalous. Before permitting such regulations we ought to be well assured that there is no other way to make traffic safe except checking its rapidity.

The general law for traffic in rivers and narrow channels need not greatly occupy us. It may be conducted on the principle of the rule in the streets, namely, that the traffic one way should hug one shore; and the traffic the other way hug the opposite shore, with the provision of proper signals, so that when one ship designs either from accident or necessity to take the wrong shore she may announce such intention to an approaching ship which might otherwise be endangered by her movement; or the traffic might be managed wholly by signal without any right or wrong shore. The ship going one way might always take command, by signal, of the ship going the other way and direct her which side to take.

It will be observed that whether in the streets, or in rivers and narrow channels, the question is simply right of way. The vehicle, or the ship, which has the right of way, may legally exercise it at proper speed, and ought not to be called on to check that speed for the ship which has not the right of way, unless extraneous circumstances compel the latter ship to cross her path, and then she should use a warning signal to show that she is so compelled. Where, however, there is no right or wrong

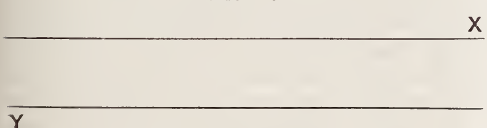
side, the signal made by the ship which has the right of way must be obeyed by the other. Traffic in rivers and narrow channels is, however, complicated by the fact that small sailing vessels, making their way when the wind is adverse must cross and recross the up and down streams of traffic, bringing about to some degree a state of affairs analogous to that at crossings in the town, or in the open sea. Such complications will here be only mentioned, their proper treatment comes under a subsequent heading.

Passing away, then, from the question of traffic in rivers and narrow channels and its analogies to traffic in the streets, we come to the far larger and far more important question of crossing traffic in the open sea and its analogies to crossings of vehicles such as we see at the Mansion House and Trafalgar-square.

It is almost obvious that no policeman is wanted on land, and no rule of the road is wanted at sea, to regulate the safe crossing of any two vehicles or any two ships, unless these are both proceeding towards one point at such a rate of speed as will bring them to it at nearly the same time. If they are not proceeding towards the same point, they do not, and cannot, interfere with one another, and no traffic regulation is necessary between them.

Thus, suppose the ship X. is steering west, and the ship Y. is to the west and south of her,

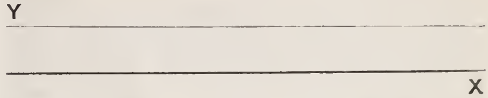
Fig. 1.



steering east, there is no reason to interfere with either of them by any rule of the road, Even if their paths are only 20 yards apart, so close, indeed, that there is a chance of rubbing sides together, yet is there no reason for any rule of the road between them. The avoidance of risk of collision in such a case is a matter for the common sense of either or of both the commanders of ships. The slightest movement to the right by either ship instantly removes all risk of collision, and the only thing which can make a greater risk of collision is a movement to the left by either ship; and if common sense did not determine the avoidance of such movements, we may be pretty sure that no rule of the road would.

Or if it were the other way, and the ships were about to pass right side to right side, if their parallel and opposite courses lie so close to one another that there is a danger of rubbing sides, it is a matter of common sense for one or for both ships to move a trifle to the

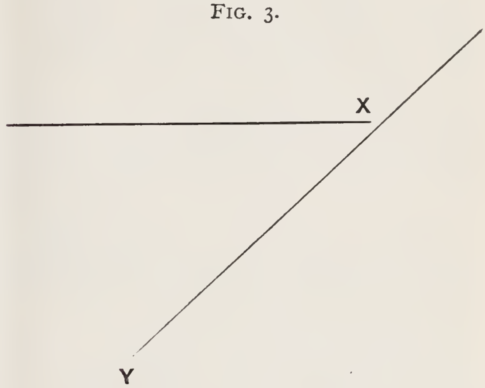
Fig. 2.



left so as to make sure of avoiding risk of collision. And if the common sense of those in charge did not convince them that a movement to the right was the one thing to be avoided, we may safely say that no rule of the road would.

Suppose, again, that X was steering west (Fig. 3), and Y were S.W. of her, steering to

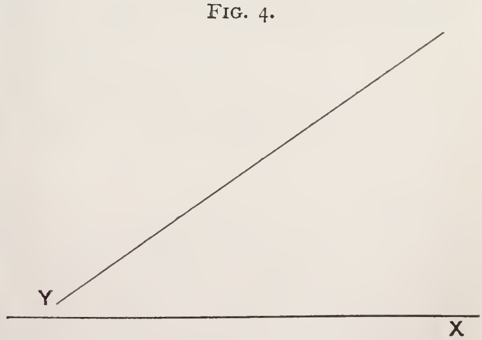
Fig. 3.



the eastward of N.E., it is plain that, provided both ships go on exactly as they happen to be, neither impedes, or could impede, the progress of the other, and so no rule of the road is necessary between them.

Suppose, again, that X was steering west

Fig. 4.



(Fig. 4), and Y, to the west and north of her, was steering N.E., here neither ship can im-

pede the progress of the other, provided they both go on as they are going, therefore no rule of the road is necessary—the ships do not concern one another in the least. None of these ships are steering for the same point, and it is that fact that excludes the necessity for any rule of the road.

All this is plain enough, and not to be disputed. But it rests entirely on the supposition that each ship knows her situation with regard to the other, in a general way. It supposes, in Fig. 1, that X knows that she is on the left-hand side of Y, and that Y knows she is on the left-hand side of X; also that each knows she has the other on her own left-hand side. In Fig. 2, it supposes that both ships know that the conditions are reversed. In Figs. 3 and 4, it supposes that each ship knows they are in those situations.

In the daytime, in clear weather, there is no reason why they should not know these things, as well, indeed, as two vehicles might know them; but at night and in fog it is different. If no artificial means of conveying the further information is adopted, X, in Fig. 1, at night or in fog might know that Y was to the left of her, but she could not tell whether she was to the left of Y; Y would be in the same state of ignorance in regard to X. The same half-knowledge would exist in the other figures; X in Fig. 4 would know that Y was to the left of her, but she would not know whether Y was steering S.E., or N.W., or N.E.

On such a condition of things we can, no doubt, exercise a choice. We might introduce a rule of the road which proposed to make things safe for these ships at night or in fog, on the supposition that they could not know whether it was safe to continue their course and speed; even though one recognised that no rule would be necessary if they knew all; or we might endeavour to cause each ship to make such indications to the other as would disclose the side that was turned towards her. You will note that this is all that is wanted. Neither ship in the least wants to know the exact course of the other; and it matters to neither whether the other is going 3 knots or 20 knots.

Reverting to the history of our rule of the road, which we must from time to time do, in order to understand it, we must note that we dealt with the question, as regarded steamers, in the first way in 1840, by making a rule of the road for them which might be said to have been equally operative at night and in fog, and did not require knowledge of the other ship's relative condition. Practically, the rule came to this, that steamers, seeing or hearing other steamers, must not imagine conditions of safety in proceeding, unless the safety was very broadly marked indeed. It was every steamer's duty, on approaching another steamer, to assume danger, and to turn to the right, to make certain that each should pass the other on her left-hand side.

Eight or nine years after this question was so dealt with in one way, the other way of dealing with it was introduced. Steamers were provided with red and green side lights, which, in Fig. 1, at night showed X that Y's left side was turned to her; or, in Fig. 2, showed the opposite, and the same in Fig. 4.

Now, either of these methods were proper, but hardly both of them; and it was a misfortune that this was not perceived for a great many years. It was not till many ships were sunk by the operation of the law that attempts to limit its action were made, and some, perhaps, of its evil still remains.

The point was that when, as in Figs. 2 and 4, the ships each saw each other's green lights to the right, they would have known they were safe had there been no rule of the road at all. But there being a rule which ordered them both to turn to the right if there was what was called "risk of collision"—a condition never yet defined—there was always a doubt in the mind of each commander whether or not the conditions were such as to put the law in force. Perhaps neither thought the case was under the law, but one of them often thought that the commander of the other ship might be inclined to differ from him, and so, to be safe in law, he turned to the and made a collision which would never have occurred had there been no such law; and then, when the case got into the Courts, the commander who had not turned to the right right was always condemned, for the fact of the collision showed that there had been previous risk of it, and it was always—almost naturally—laid down that it was safe in law to assume risk of collision, and unsafe not to assume it. The Courts, at any rate, in more modern times, never felt themselves authorised to question the goodness of the law as a preventative of collision, and spoke only of the damage that resulted to such as failed to obey the law.

But, paradoxical as it may appear, it can be truly said that the addition of the coloured side lights to steamers at night, which by themselves ought to have been an element of

safety, were, when superposed upon a rule of the road which ignored their existence, a source of special danger to navigation.

But, though, after the establishment of coloured lights, steamers in such positions as those of Figs. 1, 2, 3, and 4, had equal knowledge of their safety at night as in the daytime, nothing was done, or attempted to be done, to show by sound signals in fog how the sides of the ships lay; hence two steamers approaching, blowing their steam-whistles "indiscriminately," had no reason to doubt about obedience to the law which ordered them both to turn to the right. If a rule were a good one, calculated in the large majority of cases not to convert a position of safety into one of danger, and also, in the vast majority of cases, to turn a dangerous position into a safe one, its existence was logically defensible. It was one of the ways of meeting the case which required to be met to enable traffic to be carried on with speed and safety.

But at this point we do not touch on the goodness or badness of the rule.

While, however, it has been said that in the positions of safety shown in Figs. 1, 2, 3, and 4, only artificial means could assure each ship of her safety in darkness and fog, this is only absolutely true of the *prima facie* cases. On an instantaneous sight of X by Y, either as a dark, indefinable object, or as something carrying a light; or, finally, as something discovering its presence by sound, X could have no idea whether the position was one of safety, not requiring any rule of the road, or any action under one, or whether it was one of danger requiring concerted action under a rule of the road to remove the danger. Nor could Y be wiser under like conditions.

But if the element of time was brought in —if X could watch Y, or Y could watch X for a minute or two before determining or in order to determine the nature of the situation, there is an unerring guide to settle the questions of safety or danger. This is what is called in nautical phraseology, the change or non-change in the "bearing" of the ships seen or heard.

The "bearing" is the direction in which the thing is seen, or the sound is heard, and, generally, if this "bearing" or direction changes, the position is one of safety. If it changes away from the point towards which the ship noting it is steering, it is almost a certain indication of safety.

Take X in Fig. 1. If, as she progresses, she notices that the direction of Y, or of the sound that Y makes in a fog, changes more to the left, she may be assured that there is not any danger or any necessity to alter her proceeding. If Y notes that X changes her direction more to the left, she receives the like assurance of safety. So is it also in the case of Fig. 3.

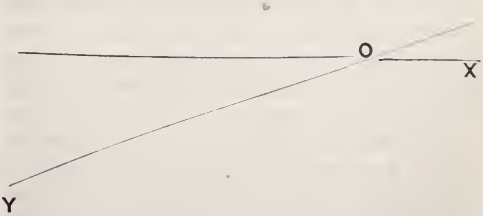
In the case of Figs. 2 and 4, X and Y are each assured of safety if what they see or hear changes its direction more to the right as they progress. It follows from this that our artificial appliances for showing, at night and in fog, which side of the ship is towards another approaching, are of more importance at short ranges, when there is no time to watch for change of bearing, than for longer ranges when there is such time.

We see, then, that though no rule of the road at sea is necessary in many cases of ships approaching each other, when the paths do not cross at all and when the ships are steering for different points, yet the circumstances of the sea are such that it is desirable to have, if we can, such appliances as will show by light in darkness and by sound in fog which side of the ship is presented to another approaching, if only to assure her of safety, and that no rule of the road is necessary under the conditions.

We have dealt thus with cases of perfect safety, where the ships are steering for different points of the compass, and where no questions of relative speed can make any greater or less risk of collision. There are a second set of cases where the rule of the road is necessary, because, if both ships go on as they are going, they cannot come into collision, but where their safety does not depend on the directions in which they are steering, but of their relative speeds. These are cases where the ships are steering for the same point, but are at such different distances from it, or are at such different speeds, as will make sure that one ship will have passed the point long before the other has reached it.

Take Fig. 5, for example. In this case X is

FIG. 5.

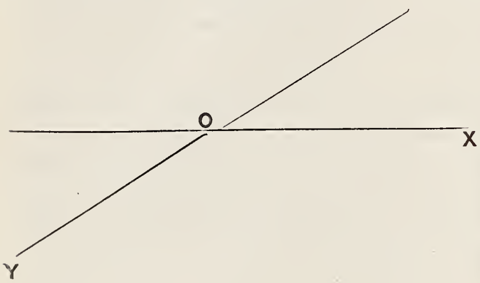


steering west, and Y, bearing to the west and

south of her, is steering (say) to the northward of E. by N. This will make the paths cross at the point O, but as Y is four or five times as far from the point O as X is, it follows that unless Y has four or five times the speed that X has, there cannot be any danger of collision, so long as each ship proceeds on her voyage without alteration of course or speed.

Take now Fig. 6, where X and Y are both steering for the point O, and are at equal distances from it. Here, if the speeds are equal, or nearly equal, and both ships continue their courses and speeds, there will certainly be a collision at the point O. But if X has a good deal more speed than Y there may not be even any risk of collision. If she has four or five

Fig. 6.



times Y's speed it is certain there is no danger in both ships pursuing their voyages. If X has twice Y's speed the position is one of perfect safety, not requiring any special action on the part of either ship, but as the speeds approach equality the danger begins to grow, and we begin to see that some concerted action between the two ships is necessary if they are to pursue their voyages in safety.

The third class of cases arise out of these. The conditions of Fig. 5 are such that no rule of the road is necessary between the two ships unless Y has very much greater speed than X. The conditions of Fig. 6 are such that no rule of the road is necessary unless the speeds of X and Y are nearly equal; but where the speed of Y is four or five times that of X in the conditions of Fig. 5, or where the speeds are nearly equal in the conditions of Fig. 6, there you run risk of collision unless some rule of the road, some concerted action between X and Y, is established to remove it.

In Trafalgar-square, or at the Mansion House, a policeman standing at the point O, would take command of both vehicles, and by holding his hand up, would compel Y to let X pass at one time, and would compel X to let Y pass at another time. But we have no policemen stationed in the open sea.

The conditions of Figs. 5 and 6, when a rule of the road becomes necessary, are:—

1. The ships must be steering for the same point, O.

2. They must be nearly equally distant *in time* from that point.

Without any rule of the road under such conditions, there would be danger of collision (1) if each ship insisted on her right to continue her course and speed; or (2) if each ship yielded her right to the other, and made such joint movements as would merely change the position of the point O, but leave the ships closer together, and still steering for the same point.

Again, without a rule of the road, each ship might yield her right to go on, and might simply check her speed. This might be a perfectly safe manœuvre, but it would be a stoppage of the traffic which we have already seen it is the business of a rule of the road to facilitate.

A rule of the road being thus necessary, when the ships X and Y are equally distant *in time* from the crossing point O, we require to consider how these ships can know that they cannot continue their courses and speeds without chances of collision at that point.

If there is time the question is decided by the non-change of bearing observed. If X in Fig. 5 notes that during a lapse of time, the ship Y in daylight, or the light that Y carries at night, or the sound that Y makes in fog, does not alter its direction, she may rely upon it that if there is not presently an actual collision, there will be a very narrow escape from one. If, in like manner, Y notes that the ship X in daylight, or the light that she carries at night, or the sound that she makes in fog, does not alter its direction, she may be assured that unless something is done there will be great risk of collision. So is it in Fig. 6. When the paths of the ships cross, which, when the ships are coming from opposite semicircles of the horizon, can be known by the fact that opposite sides of the ships are opposed to one another, there is a *prima facie* risk of collision. It may be known to be a real one by the fact that the bearings of the ships from one another do not alter.

But if there is not time to watch for a change of bearing, that is to say, if the ships do not see or hear one another until they are pretty close together, there is no real way of separating a

prima facie from a real danger of collision. Artificial means may show X and Y, in Figs. 5 and 6, instantaneously that their paths do cross at a point ahead of each, but no artificial means could show instantaneously where the crossing point was, and how far distant each ship was from it in time. A rule of the road, therefore, is required in such cases, and it must evidently be one which is not only safely applicable after time sufficient has elapsed to indicate that there will be danger of collision at the point O if both ships proceed as they are doing; but is also safely applicable on the spur of the moment, when there is no time to go beyond the *prima facie* case, and when, in fact, the danger at O must be assumed, whether it exists or not.

There is, and can be, no guarantee at sea that ships will see or hear one another—I use the idea of ships being sentient for the sake of brevity—at any named distance; it is entirely a question of weather, and your rule of the road can never ignore this fact.

If, again, the system of sound-signals be such as not to show which side of either ship is turned towards the other, the rule of the road must take account of that fact, and must be such as will not turn the cases of Figs. 1, 2, 3, and 4, which are safety cases, into dangerous cases through mistaken applications of the rule of the road.

II.—Should the Manœuvring Powers of Ships be taken into Account in Framing a Rule of the Road?

This is a very important question, on which opinions may diverge much further than might be supposed. I should put it that, as we cannot guarantee that any rule of the road imposed will only be put in force at distances beyond those in which manœuvring powers need be taken into account; as it is certain that such rule of the road will be called into action even at such close quarters as make collision inevitable, no matter what is done: it is necessary to ascertain what those manœuvring powers are before framing a rule of the road. Otherwise we might be establishing a rule that answered efficiently and safely at considerable distances, and yet became highly dangerous at short distances. But this position may not be generally accepted, and requires to be defended.

The present Lord Farrer, who, as Secretary to the Board of Trade, had a great deal to say to the framing of the present rules of the road, and whose capacity will scarcely be contested, has left us very strongly adverse opinions on this point. As Chairman of the Thames Traffic Committee of 1878, sitting after the appalling rule of the road accident in the Thames, when the *Bywell Castle* sank the *Princess Alice*, and 600 lives were lost, Lord Farrer, examining a witness, said:—

"*Q.* Now, the course which a ship makes (in turning) depends upon a good many different factors, does it not?—*A.* Yes.

"*Q.* Are there not these different factors: First of all, the length of the ship; secondly, the speed of the ship; thirdly, the power of her helm in turning; fourthly, the power she has of stopping; fifthly, in the case of a sailing vessel, the wind; sixthly, in the case of the Thames, the tide; seventhly, in the case of the Thames, the depth of the water (because a ship varies in her steering according to the depth of water under her); eighthly, the sharp corners round which she has to go. Now, for two ships meeting, you must have all these variables, must you not, because either of those ships may differ in any of those particulars?—*A.* Yes.

"*Q.* You have, therefore, I think, 16 variables, and for each of those 16 variables the course, and consequently the position, of the ships with respect to one another may vary?—*A.* Yes.

"*Q.* Now, if we make the permutations and combinations of 16 variables, we shall find that they amount to a considerable number, shall we not?—*A.* Quite so.

"*Q.* Millions and millions, if I am not mistaken. Now, all those will be different cases, will they not, and each of them differing from the cases which you have in your diagrams of the *Thunderer*?—*A.* Yes.

"*Q.* If you had diagrams to represent all those different cases put down on a sheet of paper, would you not nearly cover your paper?—*A.* Yes.

"*Q.* And what would be the value of your curves which you have got out with so much care in the case of the *Thunderer*, when applied to so many cases which differ from them altogether?"

Then, as the corollary of this, Lord Farrer put the proposition thus:—

"*Q.* If two things or two men, which we will call A and B, are in motion towards one another, and A seeks to avoid B by turning to the right, I understand you to say that when the position becomes one of extreme danger, the best thing that B can do is, not to turn to the right, and to turn away from A, but to turn to the left in the same direction as A. That appears to me, quite independently of any nautical considerations, rather a strange proposition?—*A.* The answer to that is clear. What is right for men is not right for ships.

"*Q.* Why is a rule which would bring two men into collision entirely inapplicable to ships. Surely, if two ships turn away from one another, they are

less likely to run into one another than if they turn in the same direction ?—*A*. No."

It seems to be quite clear that Lord Farrer, with his great experience of discussions on the rule of the road at sea, was sure that the manœuvring powers of ships either had nothing to do with questions of the rule of the road, or were, at any rate, so indeterminate, that it was impossible to take account of them. The members of the powerful committee which sat with him on that occasion, many of whom were seamen, took no exception to the view laid down by the chairman.

It is certain, therefore, that the point is a disputable one. But I am under the impression that it ought not to have been argued until it was ascertained, at any rate to some extent, what the manœuvring powers of ships were.

At the time that committee sat, the Admiralty had been for 16 or 17 years measuring in a very rough way the space and time required by every ship in reversing her course in turning round 180°, and in turning completely round. These spaces and times were always found to be considerable in relation to the lengths of the ships, but until just before the committee sat, no attempt had been made in England to plot out the path of a ship in turning, to ascertain what its form was. But then, following up what had been done in France, experiments had been made with the *Thunderer*, and a fairly accurate idea was given of the form of her path in turning, and of her diminishing speed in consequence. Since then, the paths of many ships of all sorts and sizes have been plotted out, and we have a general knowledge of the subject which we had not in 1878.

But it is worthy of note, that before 1854, before any experiment had ever been made with a turning steamer, Admiral Beechey at the Board of Trade assumed that steamers turned over a circle whose diameter was about 4½ times the length of the ship. He based his single and simple rule of the road on this assumption, but, unfortunately stopped short of a full examination of the consequences of it; the result was the disastrous mistake in the Merchant Shipping Act of 1854.

With a good many actual experiments, we can go much farther than Admiral Beechey did, and on much more certain ground, while we ought to be able to avoid the Admiral's error.

Figs. 7, 8, and 9 are traces of the paths described by various ships in turning at speed, the helms being moved over to the full angle as quickly as possible from the moment the order was given. Fig. 7 is the trace of the *Edinburgh's* path at twelve knots, being a ship 325 feet long and of 9,000 tons; Fig. 8 is the path of the *Rupert* at ten knots, being 5,540 tons and under 250 feet long; Fig. 9 is the path of a little steam pinnace between thirty and forty feet long, steaming five knots.

FIG. 7.

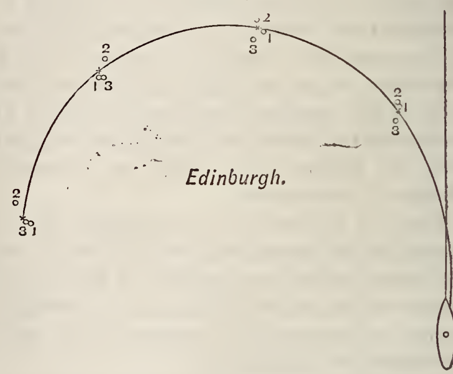


FIG. 8.

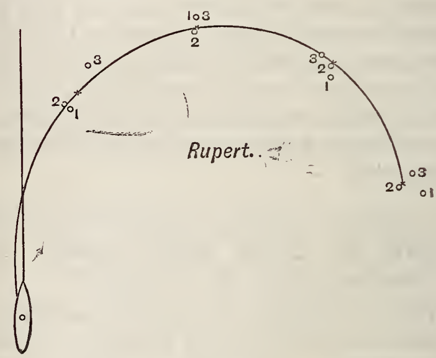
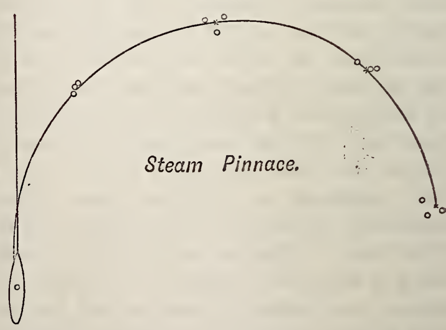


FIG. 9.



There are certain points as to these paths which must be noted. They are invariable—like a machine—under like conditions, but no conditions except difference of helm angle vary them much. They are nearly the same whatever the speed is, or whatever the trim is,

or whatever the wind is—within reasonable limits. If the helm is moved by hand, and with difficulty, higher speed will make a longer path, enclosing a larger area. But with steam steering-gear speed makes little or no difference, unless the change is very great indeed. Each of these traces is the mean of three paths, trigonometrical observations fixing the position at the moment of giving the order to put the helm over, and when the ship has turned 45°, 90°, 135°, and 180°. The little circles give the positions exactly as observed, and show the invariable character of the path.

It is seen that the path is not circular until the ship has turned about 90°. In turning to this angle—and collision cases are rarely concerned with any greater turn—it will be seen that the ship advances more to the front than she passes to the left or right. In the *Edinburgh*, in turning 90° she passes four and a half times her length to the front, while only passing two and a half times her length to the left. In the others the difference is less, and least in the pinnace. The form of path depends chiefly on the disposition of the weights in the ship, but not at all on her size, or speed, or helm angle. With less than full helm angle these ships will describe a larger curve, but it will be of the same form, every ship having her own form. But forms do not differ much more than they are seen to differ in these three cases.

The speed of the ship is gradually checked somewhat as she turns. For instance, the *Edinburgh*, at 12 knots, turns the first 45° in 65 seconds, the next 45° in about 50 seconds, the third in about 54 seconds, and the last 45° in about 55 seconds, the paths described in turning over each of the last three being very much shorter than that described in turning over the first. Similar reductions of speed are found in every ship tried.

These experiments give us the means of seeing what change a ship can make in her position when she is at speed, by putting her helm hard over as quickly as possible. We see, in the diagram on the wall (not reproduced), the case as it stands in the *Edinburgh*, of 9,000 tons, going 12 knots, and in the case of the *Thunderer*, of 9,000 tons, going $6\frac{1}{2}$ knots, each at intervals of 5 seconds.

If the *Edinburgh*, to avoid a sudden danger immediately in front of her, puts her helm over, she will place her bow at the point 7 to the right or left of her path in 35 seconds; whereas, had she done nothing, her bow would have been at the point 7 on the straight path. She has power to alter the position of her bow rather more than one-third of her own length in 35 seconds. If she continues to turn for 65 seconds, her bow will be at 13 to the right or left of her path, whereas, if she had done nothing, it would have been at 13 on the straight path. In that 65 seconds she has had power to alter the position of her bow by about a length and a third. But she has further powers. She may reverse her engines as well as putting her helm hard over. If her commander gives the order to do both simultaneously, her bow will be at 7 in the other diagram (not reproduced), to the right or left of her path, in 35 seconds, whereas it would have been at 7 on the straight path had she done nothing. She has power to alter the position of her bow about half her own length in 35 seconds. In 65 seconds her bow will be at 13 to right or left of her path, when, if she had done nothing, it would have been at 13 on the straight path. In the 65 seconds she has power of altering her bow's position nearly twice her own length. It will be obvious to you that these are her extreme powers if she were a single and not a twin screw ship. She could not change her position nearly so much if she only reversed her engines and did not alter her helm.

In looking at the diagram which compares the progress of the *Thunderer* on a straight course, and with her helm over either way, we see the same thing, in slightly different proportions.

Again, if we bring in the powers of the twin screw, showing the effect of giving the order to reverse one of the screws at the same time the order is given to put the helm over. We see that, so far as clearing the front goes, the employment of one screw reversed has a less effect than reversing both of them would have; for the front is not wholly cleared until the ship has turned 90°.

We can see from these examples—which are but illustrations of the general condition—that the helm has much greater powers of changing the position of a ship which is at speed than the engines have; and we have from this a kind of hint that, in all questions of collision, the helm is a more important factor than the steam machinery.

But I think we also see that, where Lord Farrer fell short of sound argument, was in assuming that the various elements which he not improperly enumerated as going to determine the nature of a ship's curve in turning,

would, in fact, produce so great a variety, that no general laws could be laid down. The fact is, that a few simple and general laws—those which I have stated—do govern the turning powers of all ships; and the only question remaining in dispute is whether, in framing a rule of the road, we can take these general laws into account.

As we see the same laws governing the turning of the little steam pinnace and the 9,000-ton ship, it is clear that all we can assume, as the basis of the argument, is that while ships of equal, or very nearly equal, manœuvering powers, may meet, so as to require a rule of the road between them, the general case will be the meeting of ships of very unequal manœuvring powers. But the moment we have stated it this way, we see that if we went on, we should launch into a different branch of the argument. If it comes to this, that of any pair of ships—one has inherently a greater facility for avoiding collision than the other—should we, or could we, throw the onus of avoiding danger on the ship most capable of doing it?

But we cannot go on with that argument until we have satisfactorily disposed of the question whether it does not often happen that a ship having inherently better manœuvring powers than others which she is likely to meet, frequently meets them in such relative positions that her inherently better powers are of no use to her, and that the ship with inherently less manœuvring power has, from her position at the moment, the only powers that are available for avoiding collision? And, oddly enough, perhaps we should find that question practically and historically mixed up with the question whether, in framing a rule of the road, we ought not to set aside the relative powers of avoiding collision, in favour of the relative convenience of the crews of the two ships; that is, whether we should not throw the onus of avoiding collision on the ship whose crew would be least inconvenienced by being called on to do it. In short, such questions as these cannot be raised at an early stage of the argument, and need not, in fact, trouble us except in passing reference.

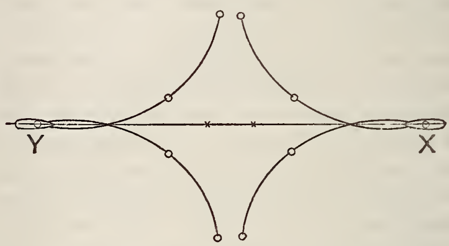
But so far, I think, we must be agreed, that in framing a rule of the road we must do it in view of the laws which govern the manœuvring powers of ships, whether we afterwards discover we need not consider them. We should be wrong to assume, *prima facie*, that we need not consider them.

III.—The Manœuvring Powers of Ships as applied to the Avoidance of Collision.

For the purpose of illustrating this further branch of the subject, I have prepared a movable diagram which will enable us to place two ships of similar manœuvring powers to the *Edinburgh* in any relative situation we desire, and will enable us to judge of the results of any movements that either or both of them may make to avoid an actual or a *prima facie* risk of collision.

If we place these ships in Fig. 10* exactly opposite one another, X steering west, and Y steering east, exactly on the same line—obviously an extreme exceptional position at sea—we observe that we must place them about nine ships' lengths apart before we reach a distance at which both ships may freely turn without getting foul of one another. With

Fig. 10.



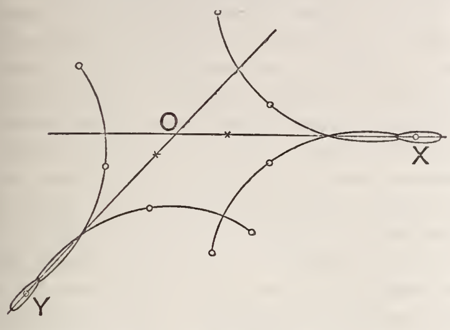
ships about 300 feet in length, this distance is nearly half a mile. So then at least we see that the manœuvring powers of ships come into play in avoiding or making collision at very considerable distances. If we move Y up to eight lengths' distance from X, we see then if both ships turn to the right, or both ships turn to the left, they will come into collision unless their speeds are such that one of them can clear the danger.

Now let us suppose Y (Fig. 11) still nine lengths' distant from X, and bearing two points of the compass (W.S.W.) on her bow, is steering N.E., while X is steering west. The point O at which their paths will cross is nearly equally distant from each, and, therefore, if their speeds are nearly equal, there is a danger of collision there, if no steps are taken to avoid it. If X continues her course and speed, and Y turns towards her, the danger

* Note that in Figs. 10 to 19 the circles on the curved paths represent the positions of the centre of the ship when she has turned 45° and 90° respectively, while the circles on the straight paths represent the position of the centre of the ship if, instead of turning 45°, she had continued her course and speed.

passes away, and Y can gradually resume her original course as X passes to the left in front of her. So would there be perfect safety if

FIG. 11.



Y contained her course and speed, and X turned towards her.

If X continues her course and speed, and Y, intending to avoid her, turns away from her—to the left—she must still cross the path of X, and the *prima facie* danger of collision remains. It is still a question of the relative speeds of the ships.

Now the crossing point has been moved farther away from X than it was originally, and so, if Y's speed were not affected, she might hope to pass the point before X reached it. But we have seen that the mere fact of putting the helm over materially checks Y's speed, so that if the path she travels over in the curve is as long as that which she would travel over going straight, before she reached the crossing, it is certain it will take her longer to reach the crossing over the curve than it would take her on the straight path. That is to say, she may be making collision more, and not less, certain than it was before.

Nothing is of course more likely than that Y—a steamer—having turned away from X, and seeing, as she turned, that she was not really clearing the danger, should reduce her speed, or even stop and reverse her engines. But it is obvious that this can only make the danger worse. Y, in turning away from X, has made an effort to get beyond the crossing point before X reaches it. But this slackening of speed, is exactly the thing to prevent her doing what she wishes. Any rule of the road therefore which should encourage reduction of speed, and at the same time permit this turning away from the danger, must be radically—perhaps fatally—wrong.

But we see that if Y had gone on, she would have crossed X's path at a small angle, offering as it were, a small target for X to steer clear of, but now, in crossing X's path while turning, she does it nearly at right angles, leaving to X the largest target possible to avoid.

We have to remember that if X's stem arrives at the crossing point just as Y's stem reaches it, there will be collision. So also, if X's stem reaches the crossing point before Y's stern has cleared it, there will be collision. But that makes the target which X has to avoid, twice the length of Y—600 feet, if Y was 300 feet long. Whereas, if Y had been in X's path with her head pointed towards her, the target that X would have to avoid would be only the breadth of Y—60 or 70 feet. We have seen that the *Edinburgh* cannot possibly clear her path to right or left, as much as 300 feet, when she is going twelve knots, by putting her helm over, and reversing her engines, in a less distance than three ships' lengths, and in a less time than 95 seconds.

Altogether apart from any question of a legal rule of the road, it would be bad seamanship for Y to turn away from X, or for X to turn away from Y, by way of avoiding her. If Y assumes that X will continue her course—no matter what she does with her speed—the seaman-like step for Y to take would be to turn towards X sufficiently to bring her to bear a little to the left of the new path; she might steer a little to the eastward of E.N.E., gradually coming back to N.E., as she saw X clearing her path to the left. But it may be seen that if Y turns away from X, and X turns away from Y, the danger of collision is avoided. That is so. But then Y has forced a movement on X which is not necessary, and the movement misses the point of a rule of the road which should not unnecessarily interfere with traffic; but even then they are not clear of one another and able to resume their respective courses.

There is yet another pair of movements possible which must be considered. If Y turns towards X, X might, on the same argument—supposing no legal rule of the road—turn towards Y. This is so. But then we can see that it is very unlikely that each ship should make and continue their turns simultaneously. One would be almost sure to observe that the other was further advanced on the turn than she was herself, and would reverse her helm. It would not be seamanlike, for instance, for Y to alter her course more than a couple of points, and she should then steady her helm. The same rule of seamanship would apply to X. It is not easy to suppose such a state of things as would allow these ships each to turn exactly 2½

points (say) at exactly the same time, and then to find the one steering exactly for the other. If they were not so situated, the danger of collision would be past.

The position in which we place these ships is a fundamental one. It is that of two sailing ships close hauled on opposite tacks when the wind was N.N.W., and it is the position on which the ancient rule of the road was based.

What was that ancient rule of the road? It was not reduced to writing, it was not status tory except in the Royal Naval signal-books. Otherwise it was an immemorial custom of the sea, the interpretation resting on the judgments of the Admiralty Court in the trial of cases of collision. It was, in brief, that the ship X, being on the starboard tack, was to go on, taking no notice of Y, and then Y, being on the port tack, was to "give way" to X.

When the rule was put into words in the naval signal-books, it was said that the ship X was to "keep her wind," and that the ship Y was "always to pass to leeward," or to "bear up," or to "give way." That is to say there was no license for Y to turn to the left; she was distinctly told she must turn to the right, that is *towards*, and not *from*, the ship she was to avoid; and the Courts made it even stronger. The ship ordered to "give way," they said, "is to keep out of the way by avoiding the bows and going astern" of the other vessel. The ship Y, they said, "ought *never* to put her helm a-starboard" to turn to the left. Even if she were in doubt as to whether, from the direction of the wind, she had not herself a right to go on, she was still to waive the supposed right, and to turn towards the other vessel.

We can see well enough that as we have it before us, this rule, when carried out, would enable these two ships to proceed on their voyages with the least possible disturbance of traffic, and in perfect safety.

Now we see that it was the wind which enabled X and Y, under the old rules, to come to a common understanding. The ship with the wind on the starboard, or right side, knew she had the right of way; the ship with the wind on the port, or left side, knew she had no right of way, and must, under no conditions whatever, pass in front of X, unless she was quite sure she could do so with absolute safety without altering the course she was steering.

But, apart from wind, there was really an appeal to a common understanding. The ship X had the right to pass on, leaving Y on her left hand side; the ship Y had no right to pass on, leaving X on her right-hand side; she must turn towards her, leave her on her left-hand side, and pass behind, and not in front of X, in order to resume her proper path.

When, in 1840, it became necessary to make a rule for steamers to which the wind could not be made a common standard, it would have been possible to make a rule identical with the sailing rule, and to say that a steamer had the right to pass in front of another steamer leaving her on her left-hand side, but a steamer had no right, and must not try to pass in front of another steamer leaving her on her right-hand side. The idea, however, did not occur to anyone until 1862, and then it was the French who proposed it. But at that time the views of the principle of the rule of the road had very much altered.

Let us, however, for the sake of illustration, note how such a rule would work if it were applied universally to all classes of ships—sailing ships and steamers alike.

If we move Y round to any bearing—S.S.W., South, S.S.E., S.E., E.S.E., to East, from X—we see that as long as Y is nine lengths distant from X, the rule works perfectly. There is never any question of Y clearing the path of X, when her starboard side is towards X's port side, if X keeps her course and speed, and Y is positively forbidden to starboard her helm, and positively ordered to port it.

This point is of immense importance, as a want of clear comprehension of it led the framers of the Rules of 1863 into a dangerous error.

In illustration, we have Fig. 12, where Y bears S.W. from X, and is steering north;

FIG. 12.

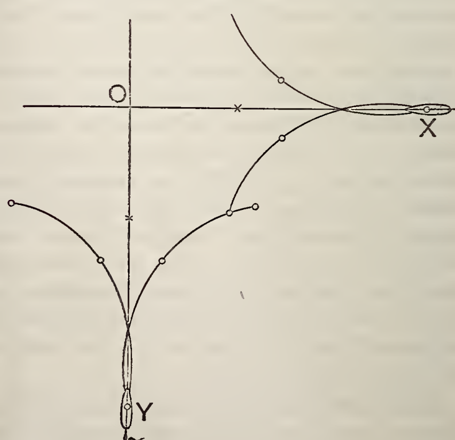
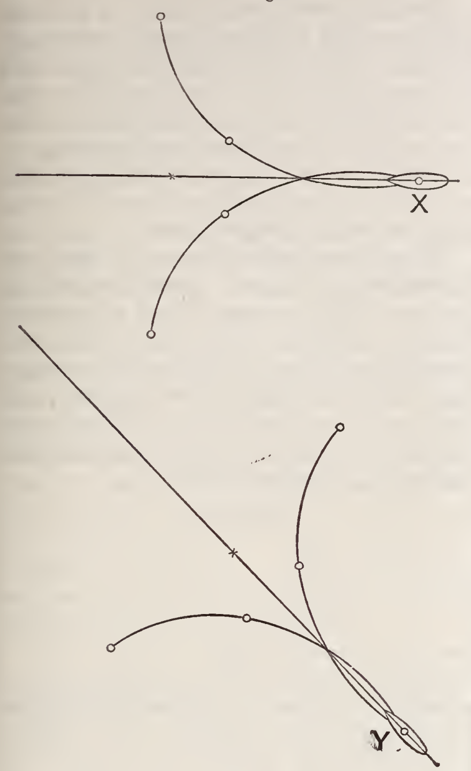


Fig. 13, where Y bears south from X, and is

FIG. 13.



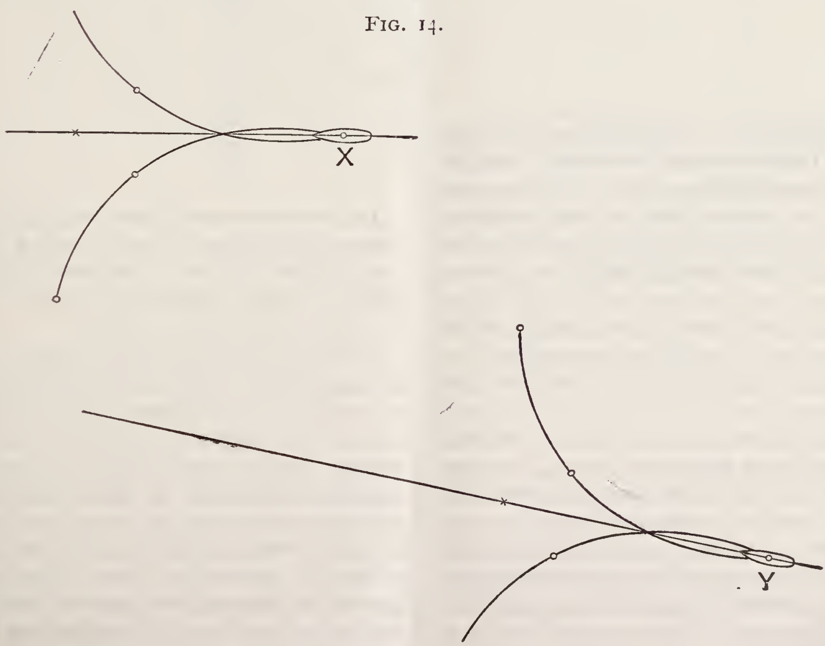
steering N.W.; Fig. 14, where Y bears S.E. from X, and is steering W. by N. And so on to an indefinite number of cases where the only conditions are that X has her left side turned to the right side of Y, and the distance apart of the ships is 9 ship's lengths or more. It is clearly to be seen that the old rule for ships on opposite tacks, in its imperative condition, is safely available for all classes of ships, however they may be approaching one another, as long as their courses cross at an angle, and they are so many ship's lengths apart.

But who is to guarantee that the rule will not be put in force at close quarters, and how will it act under such circumstances?

We must recollect that our ancestors had this before them as much as we have. Let us, therefore, look at the case as we had it in Fig. 11, but bringing in the ships into closer quarters and under rather different conditions.

In Fig. 15 (p. 338) we have X and Y as sailing ships on opposite tacks. Here X is steering west and Y north-east as before, but they are only six ships' lengths apart, and Y bears a point, instead of two points of the compass on X's port bow. We cannot, of course, say that a sailing ship's movements exactly resemble those of a steamer in turning, but we know that there cannot be a great deal of difference when a sailing ship is bearing up—turning away from the wind—while if she throws

FIG. 14.



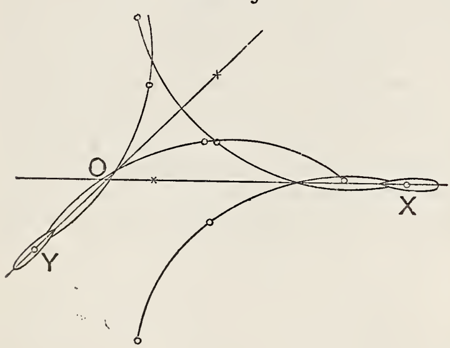
herself into the wind—turns towards it—the movement must be something like that produced by putting the helm over and reversing the engines in a steamer. In this case, the

crossing point is so close to Y that she cannot turn short of it, and if X has the necessary difference of speed and does not alter her course, there will be a collision.

Now, looking at the power that Y possesses, we can see that she connot avoid collision. If X does not avoid it, a collision there will be. It is also clear that X can avoid a collision, no matter what Y does; but only in one way, namely—by starboarding her helm and turning *towards* Y. If she turns *from* Y by porting her helm, she is still bound to come into collision, no matter what Y does.

Without going as closely into the matter as we are doing now, our ancestors recognised the position by carefully advising X. They said to her, "Though it is your right, and, in a certain sense, your duty, to continue your course, yet you must be very cautious in asserting this right, and you must yield it the moment you think danger would arise from

FIG. 15.



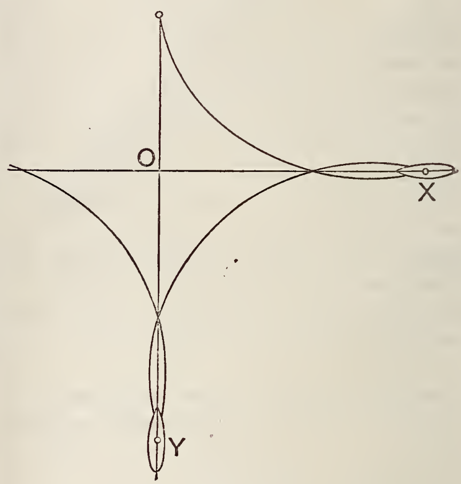
your holding to it." You can perceive that X does not require to alter her course in yielding her right, more than one point of the compass. Again, you may see that the rule forbidding Y to starboard her helm, and compelling her to port it, cannot possibly make things worse than they are. It may make them better, as it at any rate narrows the breadth of the target X has to avoid, by presenting Y to her as she approaches, more end on than broadside on.

I must observe here that the vast majority of the collisions that occur at sea, are in the form of Fig. 15. The angle between the crossing courses is generally rather less than that given. That is to say, the crossing point is generally more equi-distant from both ships, but the movements made are always of a certain character. You may long search in vain through the records of the Law Courts for cases where X starboarded, and Y ported. You will rarely find a case where neither X or Y did anything with their helms. All the cases—speaking broadly—occur when X has kept her course and Y has starboarded, turned away from X; or when Y has kept her course and X has ported, turned away from Y; or when X has ported and Y has starboarded, where each ship has turned away from the other.

Now let us take Fig. 16, which is the ditto of Fig. 12, only the ships, instead of being nine, are only six lengths apart.

What will certainly strike you in this figure is the danger of X and Y turning towards one another. We have seen not only the safety of it in the previous figure, but we have seen inevitable collision if X did not take heart of grace and turn *towards* her opponent, and that Y could not possibly make the case worse by doing the same. Do we not give fatal advice to X in the face of Fig. 16?

FIG. 16.



Let us examine the figure. What is it that makes the danger of X and Y turning towards one another? It is a number of exceptional things coming together in such a way as cannot be expected in practice.

We have two ships of equal speed, of equal turning powers, steering at right angles to each other, equally distant from the crossing point. The danger of the turn towards one another passes away if any one of these equalities is altered. If either ship has less speed than the other, she must expect to see (or hear) what the other is doing, and will be warned to reverse her helm. If the turning powers are unequal, one ship will turn inside the other, and it will be impossible for the other to strike her; if they have equal speeds and turning powers, but Y is a ship's length

nearer or further from the crossing point, or a ship's length to right or left of her present position, the ships cannot possibly touch one another if X puts her helm hard a-starboard and Y puts her helm hard a-port. If they are not steering at right angles to each other, we have already seen that the one ship will turn inside the curve of the other.

Lastly, we have to note that if the law compelled Y to turn towards X, and enjoined X to keep her course and speed, but to starboard her helm and turn towards Y if she became afraid that Y either would not, or could not, abstain from crossing in front of her, we have no reason to suppose that X would be the least likely to alter her course to a ship bearing four points of the compass on her bow. Every seaman knows that we do not trouble ourselves about vessels or lights seen, or about sounds heard, so "broad on the bow" as this. Our experience is that danger does not arise from such situations. The seaman's experience is confirmed by the fact that the registers of the Law Courts contain very few cases arising from such situations.

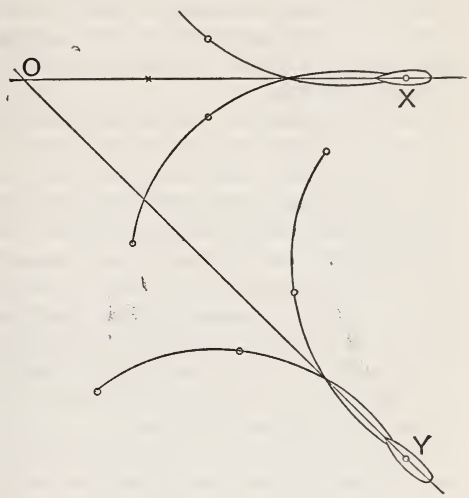
Lastly, we have this to remember, that even in a case like Fig. 16, where all things were on an equality between the two ships, it is almost certain that X will make an inequality which will remove the danger. For Y would not apprehend an immediate danger, and would probably not put her helm hard over; X, on the contrary, must apprehend immediate danger, or she would keep her course and speed. So apprehending immediate danger, she would certainly put her helm hard over and reverse her engines. But if she did these things she would put it out of the power of Y to come near her.

In Fig. 17 we exhibit the action of the rule when the ships are six lengths apart, and Y steering N.W. bears south from X. The rule, it is seen, answers perfectly, and with absolute safety.

I have as yet taken ships in the general way, supposing only that each knows the bearing of the other, and which side of the other is towards her. We hear a great deal talked of the difficulty of avoiding collision, because you can't, or don't, know the exact course or the exact speed of the vessel you wished to avoid. We never used to hear of these things till about 35 years ago; and if we are right, as far as we have gone with these demonstrations, we must, I think, come to the conclusion that it is very easy to avoid collision, even at pretty close quarters, and that in following out the ancient rule of the road, when extended to meet all cases, we do not really want to know the course or the speed of the ships with which we might possibly expect collision, if we did not take some steps to avoid it. We see so far, that when we generalise from the old rules of the road, Y must *always turn towards the danger she apprehends*, without any reference to the speed or the course of the ship which makes the danger.

But this was exactly what the Trinity Masters used to say in the Admiralty Court, before any one heard of the modern complications of a rule of the road.

Fig. 17.



But we have added, since those old times, the coloured side-lights: *red*, which, if it is properly screened, shows you that the ship carrying it has her port, or left side, turned towards you; *green*, which, if properly screened, shows you that the ship carrying it has her starboard, or right side, turned towards you.

It is constantly said that this is not enough. It has been most persistently and authoritatively stated that these coloured lights are only signals of safety or danger, but give you no hint whatever how to avoid the danger.

The late Mr. Thomas Gray's verses were quoted with approval by a distinguished naval officer in *The Times* the other day. The principle embodied in them meets with the approval of Admiral De Horsey now. They were held to be so fully the embodiment of the rule of the road now existing as between steamers, that they were issued to the mercantile marine in tens of thousands of copies.

They have never been authoritatively negatived. The verse now in question ran—as the instruction to Y in all the cases we have been examining—thus :—

> " If to your starboard *red* appear,
> It is your duty to keep clear ;
> To do as judgment says is proper
> To port *or starboard*, back or stop her."

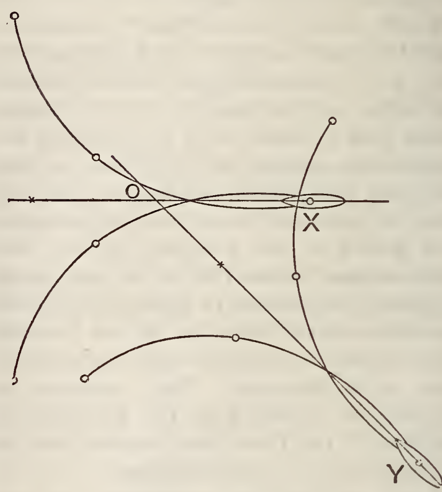
The authoritative language issued by the authority of the Admiralty, the Board of Trade, and the Trinity House, issued in pamphlet form, in about 1868, and never since withdrawn or modified, put it more distinctly, thus in effect :—" Y "—in all the cases we have been examining—is to keep out of the way of the ships carrying the red light, by porting, *or starboarding*, or going a head, or going a stern, as the judgment of the moment shall decide, and the circumstances of the case shall require.

That is to say, the main principle of the modern rule of the road is at issue with the ancient one. The ancient one absolutely and in the most explicit terms, forbid Y to starboard her helm ; the modern one—now the law—has removed that prohibition, and leaves seamen's minds perfectly open as to what they should do. In order to make it quite clear, the modern rules altered the phrase, " Give way," as applied to Y—a phrase perfectly well understood, and over and over again defined by the Courts—to " keep out of the way."

In all the cases we have seen up to this, we can, I think, discover no cause for such a change, and we can only see the danger of it. But, I think, we may suppose that in making one so fundamental, there did appear good reason. I am sorry to say there is none in the published papers on this subject. Indeed, the Trinity Masters of 1861-2 are found using the phrases, " Give way " and " Keep out of the way," as synonymous and interchangeable, and do not seem to perceive that there was anything fundamental about it. But I imagine that, if the principle of the old rule was entirely understood by the framers of the new laws in 1861-2, there must have been an impression that the addition of coloured lights made a change necessary, and the ships in Y's position might be tempted, on seeing in thick weather a red light close upon their bows, might port their helms, when, if they had starboarded, they would have saved the ensuing collision.

I know that amongst even experienced pilots there is an idea that it is sometimes safe to put the helm hard a-starboard to a red light on the starboard bow when it would be unsafe to port it. Their idea seems to rest on the case of coming up with a ship at pretty close quarters, and seeing the red light a little on the bow, as Y might see X's red light in Fig. 18.

FIG. 18.



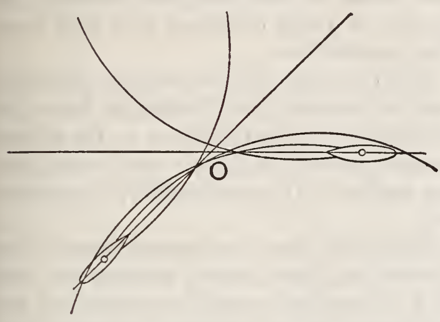
It can be seen at once that Y suddenly seeing, in thick weather, X's red light only four ships' lengths off, and two points of the compass on the bow, can give her, as it were, a wider berth by starboarding, and that, therefore, it ought to be left optional to Y to starboard and turn to the left. I imagine the argument must have rested on this idea without going any further. But with Fig. 11 before us, we cannot stop there. Y in Fig. 11 sees X's red light exactly as she sees it in Fig. 18, but it is nine ships' lengths off, whereas in Fig. 18, it is only four ships' lengths off, yet at this greater distance Y, by starboarding, may make a collision certain, when by porting she removes all danger. You cannot leave it open to Y to starboard in Fig. 18 unless you also leave it open in Fig. 11. Is it necessary to leave it open in Fig. 18 ? Evidently not. It is not possible to make a collision out of Y's port helm. Even if X were to stop and reverse, or if she were originally at very low speed, she would be far out of the way when Y passed under her stern ; and Y, alarmed and reversing his engines, can only make the case so much safer.

So far as I have understood, the answer to this argument in favour of abandoning the present principle, and returning to the old principle, is that in Fig. 18 it is only the

distance apart or the ships which makes it safe to forbid Y to starboard her helm. Put the ships closer, it is said, and you may see the necessity for allowing Y to judge on the spur of the moment whether to port or to starboard, and giving her no guidance.

This rejoinder has partly been replied to when we have seen that starboard helm may make a collision at nine ships' lengths, when port helm cannot make one at four ships' lengths. But the point is more conclusively answered by Fig. 19. Here Y sees exactly

FIG. 19.



what she saw in Fig. 18, namely, a red light suddenly appearing two points of the compass on her starboard bow. It is plain that in this position collision is inevitable. No power that either ship possesses has any capacity to avoid collision when the courses cross at an angle of four points of the compass, and the ships are but four lengths apart.

It appears to me, in short, that the argument against the old principle, and in favour of the new one, wholly breaks down; that, in fact, our fathers were right and we are wrong.

To reduce the number of collisions we must begin by teaching seamen that it is *always wrong to starboard the helm to a red light; and always wrong to port the helm to a green one.* But evidently there is more than this. Quite apart from any question of coloured lights, or means of showing which side of her the ship that you see, or hear, is showing you, the point has been that when Y has apprehended a danger to the right, she has turned to the right, as the best way of avoiding it; and when X has been afraid that she cannot continue her course safely, apprehending a danger to her left, she has turned to the left and found that if she had done anything else, there would have been collision.

See the effect of this law on cases where the colour of the light is not made out; where, for instance, only the steamer's white mast-head light is seen; Y, in such a position, may not feel herself called on at the moment to alter her course, for the ship whose light she sees may not be steering so as to cross her course. But she has a warning to be ready to port her helm should occasion arise, and that any starboard helm is either unnecessary or dangerous.

See, again, how such knowledge acts in fog. X hearing a fog-signal to the left, knows that, *prima facie*, she has no reason to disturb herself. The ship sounding is either not steering so as to pass in front of her, or else she is bound by the rule of the road to alter her course and pass to the left and astern of her. If, however, that sound closes her without altering its direction, she knows that she may have to starboard her helm, but will be wrong to think of porting it. If Y hears the sound to her right, she knows that the ship making the sound is either steering to cross her path, or is not. If not, nothing need be done. If the ship heard is steering so as to cross her path, she knows that she ought to port her helm so as to appear to steer for the point where she first heard the sound. That is just what she ought to do if she saw a red light; to steer almost for it, being certain that the ship could not be there when she reached the spot, and could hardly come into collision with her, because so many equalities as would make a collision can rarely, if ever, appear together at sea.

So you may observe that there is no real complication in the rule of the road. You throw the onus of manœuvring on one of every pair of crossing ships, and you tell her to "give way" to the other. If she cannot (as in Fig. 15) she is still not to set herself up as a judge but to try her best, and then the other ship must "give way" to her.

IV.—What the Washington Conference proposed.

This long explanation is necessary in order to make plain to you what fundamental alterations the Washington Conference Rules will make in the existing law.

We see that Y, as the ship on which the onus of avoiding risk of collision devolves, has no guide, under the existing law, in the most material element of all, for manœuvring to avoid X. She is told that in cases of seeing a red light to starboard—to the right—she must form her judgment at the moment whether it is a signal to her to port her helm or to starboard it—to turn towards it or away

from it. But she has a positive direction (Art. 18) that whatever she does with her helm (and this notwithstanding the authoritative interpretation given to another Article—Art. 16), she must reduce the speed of her engines, and, if necessary, stop and reverse (Art. 22).

The Washington Conference Rules practically forbid Y to starboard her helm, but they maintain the orders as to the reduction of speed (Art. 23), and they direct her to port her helm—to turn towards, and not from, X.

The Washington Rules (Art. 21) tell X that she is to keep her speed as well as her course. But far from encouraging the keeping of her course at all hazards, which the authoritative interpretation of the existing law (though not the Law Courts, perhaps) insist upon, X is warned (Note to Art. 21) that when the danger is near, it may devolve upon her, and not upon Y, to avoid it, and that, therefore, she must be ready to use her helm in the right way.

It may be distinctly said that the Washington Conference Rules propose to abolish the *principles* of the rule of the road now existing, and to restore those which have been more or less banished ever since 1854.

We see also that, so far as our investigations have gone, the existing principles must be condemmed, and those proposed by the Washington Conference upheld. But it is quite possible that seamen and others may be indisposed to take the scientific and experimental results now shown as trustworthy. It may behove me to show that they are trustworthy and most practical.

It might be argued that though all that has been said is right enough, and practical enough, as between two ships of the *Edinburgh* type, they are only theoretical as regards the general case. These possible objections can be easily met. Any pair of ships taken will show the like results.

Our investigations lead us to expect that if they are reliable, the following facts relating to collision at sea should be found in practice.

1. There should be very few collisions where the ships are approaching from the same quarter of the compass, as in Figs. 14 and 18. The records of the cases tried in Court make it clear that this so.

2. The collisions should grow more numerous as the ships coming from opposite quarters have their courses crossing at smaller angles. This is quite certain.

3. Collisions occurring when neither ship alters her helm should be very rare. They are so.

4. Collisions when each ship is steering an exactly opposite course on the same line, should be almost absent. They are so.

5. Collisions, when each ship turns towards the other, should be very rare; and when they occur it should be clear that either ship persevered in turning long after she had had a signal from the other to reverse her helm. This is entirely so.

6. Collisions should always involve either starboard helm by Y, or port helm by X, or such helm by both ships, and, generally, reduction of speed combined with such helm. This is entirely so.

That is to say, that the truth of the principles laid down in the Washington Rules, and the falsity of those laid down in the existing rules, is shown in two ways totally apart from one another—(1) experimentally, (2) statistically.

But though these fundamental parts of the Washington Rules, except perhaps the order for X to keep her speed, are looked at with indifference by the maritime community, and so are unchallenged, it is not so with some of the auxiliary parts of the new rules.

Certain modifications as to the use of existing sound signals between X and Y, and some substitutions in the code of fog sound-signals, have raised the most violent opposition in the marine community, as if in its general opinion any value which the Washington Conference Rules possess in other parts, are absolutely swallowed up by the terrible dangers which these modifications of the sound-signals will introduce.

It is, unfortunately, not now as easy to speak decisively on this part of the question as it is on the other. We had behind us, then, pretty good experiments, and very good statistics to go by. Now we must guess somewhat.

But on one very important part of the question our ground is perfectly certain, experimentally and practically.

There is nothing inherently difficult in sound signalling by means of long and short sounds on a wind or steam instrument. On the contrary, a complete system available for long conversations, can be learnt in a few minutes, and will be ever after found perfectly reliable for use in fog.

We know this for certain, because such a system was introduced into the Royal Navy in 1863, without any instruction at all, and has ever since been in constant use. It has been

changed in the way of being made very much more elaborate and difficult to remember, but that is all.

The notation adopted in the Navy was as below, the dots representing sounds of not more than one second in duration, the intervals between them representing silence for the same length of time; the dashes representing sounds of not more than three seconds in duration:—

1 .	6 ———
2 . .	7 . ———
3 . . .	8 ——— .
4	9 . . ———
5	0 ——— . .

If I sound these for you on a whistle, you will note how exceedingly readable they are, and how difficult it is to mistake one for another.

I think, if I had been on the Washington Conference, I should have argued—if it had been determined to add to the existing sound signals—in favour of making the whole arrangement systematic, on the foregoing basis, as being, on the whole, simpler, and more readily developed. But the facts that are known to me did not lead me in the least to apprehend that the marine community would take the strong objection now taken to what is proposed.

We must note what the Conference found existing.

(1.) Supposing that X and Y (Fig. 15) were sailing vessels, and the wind was N.N.W., then X is directed to sound one blast on her fog-horn, to show that she is on the starboard tack, and Y two blasts, to show that she is on the port tack, at intervals of two minutes, when there is fog. Supposing the wind were E.S.E., then X is directed to sound three blasts, to denote that the wind is abaft the beam on either side, and Y one blast, to denote being on the starboard tack, these signals being sounded at intervals of two minutes. The Washington Conference left these signals as they found them, except that they made the interval of silence one minute instead of two.

(2.) If either X or Y were steamers, or if both of them were, then they are each directed, if there is fog, to sound a prolonged blast at intervals of two minutes. These signals are to be sounded, whether the steamer is proceeding, or whether she has no way upon her.

The Washington Conference defined the prolonged blast to be one of from four to six seconds duration, and they directed that it was only to be used by a steamer when she had way upon her.

They substituted a new fog-signal for a steamer without way upon her; they directed her to sound two prolonged blasts at intervals of two minutes. This may be said to be the most important change made by the Washington Conference in the sound-signals. We have seen that any fog-signal made by X which does not indicate the side which she turns towards Y, leaves Y no option—as being the ship on which the onus lies of avoiding collision—but to turn her head to the direction in which she heard the sound.

I suppose that the Conference, recognising this, desired to prevent Y from making the movement in a case where it is gratuitously dangerous.

The Conference substituted the fog-signals compulsory on X or Y, being steamers, two which are of a special character, and can only be in exceptional use. If either X or Y were towing another vessel she is directed to sound, instead of either the foregoing signals, a prolonged blast followed by two short blasts —that is, the figure 0 in the code—which was in use for more than 20 years in the Navy, or the letter A according to present notation.

The Conference made it optional to the vessel towed—which at present makes no signal—to use the same figure 0, or letter A. If either X or Y were laying or picking up a telegraph cable and were to hear the fog-signals of an approaching vessel, the Conference directed that she should answer it by sounding three prolonged blasts. There is the peculiarity about this signal that it can only be sounded in answer, and is therefore limited in use.

The same is to be said for another change made by the Washington Conference. A vessel which is unable to manœuvre, is directed to sound four short blasts in answer to an approaching ship's fog-signals. That is, I suppose, that if Y, in Fig. 11, were to have her steering gear damaged, and to hear the prolonged blast of X to the right, she would answer by sounding four short blasts. Or, more probably, a very large ship, proceeding up a narrow channel in fog, being obliged to keep her course because of the narrowness of the channel, is intended to use this signal in order to warn smaller ships o her inability. I say more probably, because if X or Y were in open water they could scarcely keep way on them, and yet be unable to manœuvre. If they were unable to manœuvre

they would be unable to steer, and therefore would stop, and then the sound-signal denoting a stopped vessel—two prolonged blasts—would be the more appropriate signal.

As far as fog-signals for ships under way go, the changes proposed by the Washington Conference are therefore six in number, as follows :—

1. Defining the long blast already in use.

2. Reducing the interval between the fog-signals of sailing vessels from two minutes to one minute.

3. Substituting a signal for steamers without way on them for the signal denoting having way on them, which they now sound.

4. A substitute signal for vessels having others in tow.

5. A substitute signal for a vessel laying or picking up a telegraph cable.

6. A substitute signal for a vessel incapable of manœuvring.

This is not a very extensive list, and it may not be easy to show precisely in what way it may increase the dangers lurking below the present list of signals.

But there are another set of sound-signals for ships under way now existing, which can only be lawfully used when ships see one another, and are therefore unlawful in fog; and the Washington Conference, finding them optional, has made them compulsory.

If we take X and Y in Fig. 11 as being two steamers in sight of one another, Y can legally sound one short blast to denote that she is porting her helm to turn towards X, or two short blasts that she is starboarding her helm to turn from X. X, however, cannot—even in such a case as Fig. 15—signal that she is starboarding her helm, for these signals are only lawfully used to indicate a movement authorised by the regulations, and no helm movement for X is authorised. But both X and Y may sound three short blasts to indicate that their engines are going astern.

The Washington Conference left these signals as they found them, except that they defined a short blast to mean a blast of one second's duration; but, as I have said, they found them optional, and they made them compulsory.

These embrace all the sound-signals existing or proposed for ships under weigh.

Ships at anchor in fog are now directed to ring their bells. The Washington Conference added that when a ship was at anchor in a fair way which was an unusual place, she should, besides ringing her bell, make the steamer's signal for being stopped—two prolonged blasts on steam-whistle or fog-horn.

I confess that after considering the enormous importance of placing the main principles of the rule of the road on a true basis, and striking directly at the almost invariable ultimate cause of collision—wrong helm—the discussion of the goodness or badness of the modifications proposed in the sound-signals comes to me as somewhat of an anti-climax. I know for certain that if we could prevent seamen from using wrong helm when they act to avoid collision, collision would almost disappear. So, from my point of view, I require to know in what way the changes proposed would induce wrong helm before I can be seriously alarmed about them.

We must recollect that for X, all through, the changes proposed can have little or no signification, whether she makes them or leaves them, except in the case of Y making a signal that she is incapable of manœuvring in fog. But even in this case the signal can only be cautionary.

As far as Y is concerned, we have seen that unless X could make a fog-signal to her to signify that her starboard side was towards Y's starboard side, or that her port side was towards Y's port side, it would always be Y's business to turn towards the sound. Therefore, again, all these signals are but cautionary to Y.

I can, in fact, only see clearly one possible source of danger arising from the proposed changes, as far as Y is concerned. If Y—say in Fig. 11—should hear X's fog-signal of one prolonged blast, meaning that she had way upon her, and should suppose she heard two prolonged blasts, and should understand that Y had no way upon her, then she might keep her course, and so make a collision. It is not a very likely contingency, but it must be admitted as possible. But then we must remember that now, when X sounds a signal which denotes having way upon her, while yet she is still, she runs a certain danger from Y.

I have met one or two cases where collision came about from this cause.

It is very generally stated that, under the Washington Conference Rules, there will be in fog much more whistling than there is at present. This appears to be a mistake. Except in shortening the interval between the signals in sailing ships from two minutes to one minute, and in adding the wind or steam signal to the bell signal of ships at anchor in fair ways, the Washington Conference does

not appear to have added to the number of fog-signals. They have only substituted one kind of signal for another. But in the sound-signals for steamers which are not lawfully used in fog it may be that making them compulsory will increase the amount of signalling, and by consequence, of confusion. But I am bound to say the evidence is the other way. Run your eye over the records of a score or two of the collisions that have lately come about in narrow waters, and mark how signalling on both sides is deposed to.

When I last made personal inquiry into this particular part of the subject—six or seven years ago—it was made perfectly plain to me that seamen never restricted themselves to the legal use of the sound-signals, but in narrow and crowded waters they whistled "indiscriminately." The Thames Traffic Committee, which sat in 1878, found and reported the same thing, and seemed rather to think that the difficulty lay in checking signals without authority, than in inducing signals by authority.

Thus, I cannot escape from the clear conviction that no step is justifiable on side issues which may delay the main issue of the establishment of a true rule of the road. We are not justified in delaying to pass the Washington Rules into law, because we may reasonably take exception to the changes in the sound-signals which they have introduced.

The principles of a true rule of the road will never be understood and acted on by seamen as long as the present rules remain law. Corrections in the sound-signals proper for carrying out a true rule of the road cannot, in fact, be properly made until seamen fully understand what truth is, which they certainly do not now.

V.—The Screening of the Coloured Side-lights.

The question of screening of the coloured side-lights has nothing to do with Washington, but it has been so much debated that a few words must be said on it. The existing law prescribes that each coloured side-light is to be visible from right ahead over an arc of 10 points of the compass, to 2 points abaft the beam. It also states that the lights were to be fitted with inboard screens projecting at least 3 feet forward from the light, so as to prevent these lights from being seen across the bow.

As to this, we must first observe that what is prescribed is not possible. No light is a mathematical point, and therefore if the full light is so screened as to show right ahead, part of the light must show across the bow. If, on the contrary, none of the light is allowed to show across the bow, the full light cannot be seen right ahead of the light.

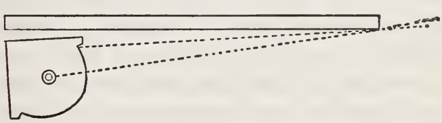
There has again sprung up an odd sort of legal technicality as to the meaning of "right ahead," which would not occur to seamen, and would in any case be generally repudiated by them. It is claimed that "right ahead" means in a line with the keel ahead of the ship, not in a line drawn through the light and parallel to the keel.

But these theoretical niceties ought never to have been allowed to creep into the question. The meaning of the coloured lights—which we have seen to be a sufficient one to avoid collision—is simply to show which side of a ship is turned towards you. Now, if the lights are seen across the bow, and are not of exactly equal strength, an observer is liable to see a green light only, and to believe himself on the starboard side of the ship showing it, yet ought only to see her red light. Y, in Fig. 15, for instance, might be induced to continue her course if X's green light showed across her bow and her red light was at the moment dim.

When I began to study these questions, in 1867, I found many collisions which were due to this cause; and then, reading the order as to screening with a 3-foot screen and lanterns in common use, I found that the full light on either side generally showed 10° or 12°, and in the case of the best found ships, using very large lanterns, a good deal more.

The common fitting is given in Fig. 20, which is taken from the Board of Trade

Fig. 20.



Surveyor's instructions of 1878, and is a favourable specimen, the full light only showing about 7° on the wrong bow.

The investigations explained to me why it was we so often saw both coloured lights at sea; but then it also showed me the cause of much collision. But in the meantime the Government, in order to restrict the improper use of port helm under the wrong principles of the law of 1840 for steamers, and of 1854 for all classes of vessels, declared that it was only to be used when both coloured lights were seen ahead. It had not been observed that unless the lights were seen on the wrong bow, con-

trary to law, they could not both be seen together.

The Government were, therefore, in an anomalous position when the matter was brought before them. They met it by issuing the following instruction to the Board of Trade Surveyors :—

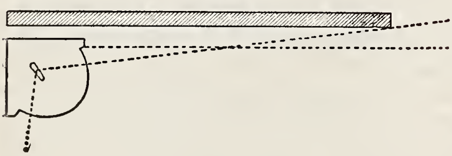
"The inboard screens should be so fitted as to prevent the red and green rays crossing too close to the ship . . . .

"For both lights to be seen ahead, it is necessary that the red and green rays should cross at a certain distance ahead. Surveyors will find that if the inboard edge of wick touch a line that is parallel with the keel of the ship, and that cuts the outer edge of the forward end of the inboard screen, the rays will cross suitably."

Of course, this fitting, if it had been adopted, would have secured that only partial light, and never the full light, could be seen on the wrong bow, but that the full light would be seen right ahead of the light.

But none of the illustrative diagrams corresponded with the text; they all showed, as Fig. 21, which is one of them, showed, the full

FIG. 21.



light crossing several degrees to the wrong bow. Consequently, though the fittings adopted had the distinct effect of practically banishing the light of both coloured lights from the seaman's eyes; of removing a cause of collision, the sight of the wrong light; and of practically killing the pernicious rule of X and Y porting their helms to avoid collisions that could only be avoided if X starboarded, as in Fig. 15. Yet it left the screening vague; and sometimes surveyors were more, or sometimes less inclined to allow the wrong light to be seen.

The Board of Trade, wishing to put an end to this vagueness, produced, in January, 1893, the much-abused Order in Council. This directs that the line joining the outer edge of the screen shall be at an angle of 4° with the keel line of the ship.

It will be observed that this does not determine the proportion of light which shows on the wrong bow; it will be much, if the width of the wick is large, but in no case, you will observe, can the question between what existed in December, 1892, and what was ordered in January, 1893, be a very important one.

If I had been officially connected with the matter in 1892, I should either have recommended leaving well enough alone, satisfied by the evidence of the Law Courts that the screening of the lights was not so very far out, or if I had been impressed with the necessity of perfect screening, I should have reiterated the instructions existing in 1878, and furnished diagrams to the surveyors in accordance therewith, showing that the line joining the inner edge of the wick and the outer edge of screen should be in a line parallel to the keel —being the recommendation I made to the Board of Trade in 1868, and have never seen reason to recede from.

The rule of the road at sea suffers from two difficulties. The scientific men declare it is too practical a question to be dealt with scientifically, and when it is treated practically practical men declare such treatment is too scientific.

But still, watching it as I have done closely for about twenty-eight years, I am very hopeful that the controversies which began in 1840 may be approaching a conclusion. When practical men understand that it is a question pre-eminently suited for scientific treatment, and when the scientific men comprehend that it is not beneath them to apply themselves earnestly to the solution of a question of such vital importance to a maritime nation, the matter may be permanently settled on all issues, and controversy will cease.

DISCUSSION.

Mr. C. F. TORREY said though the paper was exceedingly interesting, and the points made were not only true but very useful, he could not agree with Admiral Colomb in much that he had said with regard to fog-signals and side-lights. He had explained how the sound-signals were made in the Navy, but he did not think anyone present could repeat them, or that they would easily understand them, even after a week's practice. How much more difficult would it be to understand them in crowded waters, where signals were being made all round; it seemed to him it would be impossible for one ship to know whether a long and short sound came from one steamer, or from two, especially in a crowded place like Beachy Head. All who navigated ships would agree that the simpler signals were the better. If they only had to deal with vessels manned by highly-

experienced officers, as in the great lines of steamers, the rules might be made even more complicated, and there might be more safety; but they had to deal with a lot of indiscriminate craft, sailed by officers who were not all competeut, though they had Board of Trade certificates; many of them, also, were overtired with constant work, and they would not distinguish between the long and short sounds. With regard to side screens, it had been pointed out that in former days the light crossed the bow at a much greater angle than at present; but that did not prove that the present rule was right, it only showed that the surveyors of the Board of Trade, prior to altering the side lights to their present position, did not do their duty, and it was a question whether many collisions had not been caused by the excessive angle at which the lights crossed. A ship having her light properly screened, so as to be parallel to the keel, and travelling in one direction, might meet another vessel with her lights improperly screened; if the first was on the starboard bow of the second, she would see all three lights of that second vessel, while the latter would only see one light, and the result was that neither vessel understood the other's position. [Mr. Torrey drew on the board a diagram shewing such a case in which a collision ensued, one of the vessels being a foreigner.] This showed the danger which arose from two vessels being screened differently; had they been alike, they would have both ported their helms and passed safely.

The Hon. R. C. PARSONS said he could not understand how it happened that a steamer with a twin screw did not turn more quickly when one screw was reversed and the other kept going ahead, and he should like to have the matter further explained.

Mr. FRANCIS COBB said he gathered that, in the Navy, they had a complete system of sound-signals for the numerals 1 to 0, but not that such a complicated system was to be introduced into the merchant navy. As the Admiral was no doubt aware, sounds were sometimes very puzzling; for instance, when entering the Thames in squally weather, when there were fog banks about, at times you got a distinct echo, which might be very misleading, and it would be very difficult to know from where the sound came. In such cases, and where the passage of ships was confined to certain channels, the simplest possible signals should be in use, and he thought lights would have to be trusted to more than sound. He should like some further information on this point.

Mr. CHRISTIAN asked whether the sound-signals, which had been described as in use in the Royal Navy, were employed to signal as proposed by the Board of Trade in the new regulations, or to signal numerals in a code, in the same way as flags were used in clear weather.

Mr. C. E. KILWAY said he had recently sent a letter to the *Times*, pointing out that what was really required was a ready means by which two or more vessels could communicate to each other their respective courses, and that this could very easily be arranged by a code of signals. He should be glad if Admiral Colomb would state his opinion on that point, which he understood, from a letter of his on January 19th, was favourable.

The CHAIRMAN said he should like to ask for further information on the point put by Mr. Parsons with regard to the twin screw. He understood the Admiral to say that if one screw only were reversed the ship would describe a greater curve than if both were reversed. He thought, from his own experience, that there was a mistake about that. Having drawn a sketch of the stern of a ship, with the two screws, one on each side, and the rudder, he pointed out that if one screw were reversed when the rudder was hard over, the pull of the screw tended to counteract the action of the rudder, and turn the ship's head the other way, and that to get the proper effect of the two screws acting in opposite directions the rudder must be left amidships. They had been laying cables with twin screw ships, and found they could turn a ship round a buoy, nearly touching it all the time, by turning one screw ahead and the other astern, leaving the rudder amidships.

Admiral COLOMB, in reply, said there was, of course, a difficulty in distinguishing sound-signals from one another in crowded waters, but under the new regulations the number of signals was not increased in any way, the only difference was that some of them were changed; a ship stopped would not make the same signal as she was bound to make when going ahead. At present she might make a signal which would lead another vessel to think she was going on. A ship towing another now made a danger signal; the only difference introduced by the Washington Conference was in the signal she made. All you could say against the system was that the signals might be mistaken, but that was so now. There was no distinction now between a ship which was stopped and one with way upon her. In crowded waters seamen would whistle whatever regulations were made; that was stated in a report by a Committee in 1878, that the practice in crowded waters was for steamers to whistle indiscriminately. The changes proposed by the Washington Conference were really cautionary. If Y, hearing a sound-signal on her starboard had now to turn towards it, no matter what the signal was, she would still do it, and if it were a ship towing or not under command, it was the safest thing to do. He did not disagree with anything Mr. Torrey had said about the screens. A light showing across the bow to any extent was an evil, but as any light used was not a mathematical point, it was impossible to get one which would be

seen on a line drawn through it parallel to the keel, which, at the same time, would not show on the wrong bow. All you could do was to see that the full light could not be seen on the wrong bow. The evil of a wrong light being shown was apparent to everyone; but it was no use making a mountain out of a molehill, and the difference ordered by the Board of Trade in the screen was comparatively slight. It was very seldom indeed in practice that you saw both side-lights, and when you did, it was only an instantaneous flash. With regard to the questions put as to the twin screws, he could only say that the diagrams of the *Thunderer* gave the exact facts as observed; it was not a question of hypothesis. He thought the Chairman was probably right in the case of a ship with no way upon her; but when she was going through the water at the rate of 12 or 14 knots, as far as his own experiments went, putting the helm over was a distinct advantage. That again was proved by the fact that the stopping of one screw, not reversing it, had something the same effect as reversing, but not to the same extent. She turned in a shorter space, but in about the same time as with the helm hard over and both engines going ahead. If the ship had no way on he should agree with the Chairman in reversing one screw and going ahead with the other, not touching the helm. Mr. Cobb had referred to the difficulty of distinguishing sound-signals in fogs, and so on, and of course it was so, but in that matter the new rules did not make much difference. The sound-signals were used in the Royal Navy in fog only, not in clear weather. Generally speaking, the curves were the same in turning a ship to port or starboard; there were very slight differences sometimes in single screws, more than in twin screws, but nothing worth noticing. In one case only had he found any important difference which was never explained. Another question had been asked, whether it would not be well if ships had the power of commmunicating to each other the course they were upon, but an examination of the paper would show that the coloured lights gave all the information that was required to avoid collision. There was no need to know the exact course or the speed of the ship you wished to avoid; you only wanted to know which side was turned towards you. That informed you, first, whether there was any risk and if there were any necessity to do anything; and, secondly, what to do to get out of danger.

The CHAIRMAN then proposed a vote of thanks to Admiral Colomb, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

THE SILK INDUSTRY IN SYRIA.

The production of silk in Syria has, says the *Journal de la Chambre de Commerce de Constantinople*, considerably increased of recent years. The towns and villages in which the greatest attention is devoted to the sericulture are the following:—Baalbek, Serin, Ras, Machghara, Sahbine, Chtora, Hasbaya, Aïn-el-Hraiche, Ain-Ata, Brit Lahie, Nabeh, Malonia, Giroud, Maâra, Sidnaja, Essal-el-Ward, Douma, Khyara, Chafounie, Jaramana, Chabaâ, Catana, El Hamé, and Tsaxa. In 1893 about 900 pounds weight of silkworms eggs were used in these towns and villages. The eggs used in Syria are of Corsican origin; the greater part come from France and a small quantity from Italy. As regards the Japanese varieties these have entirely ceased to be imported. It is the merchants of Beyrout and the Lebanon who engage in the business of importing silkworms' eggs, and who sell them to the Syrian breeders. These merchants exercise the greatest care in all their operations, and some even go so far as to travel themselves to France to make their purchases. All the eggs imported are subjected to a most rigorous examination, and in some cases they are examined by means of microscopical instruments. They arrive in boxes of about twenty-five grammes weight, and are sold at prices varying from three to six francs according to quality and guarantee. The payments are made at once, or at the end of the harvest, in kind—that is to say in cocoons. In the latter case the amount due to the seller varies according to the district. For example at Rachaya, in the villages of Ouadi-el-Adjam and Douma, one seventh of the silk harvest is given; at Baalbek and Hasbaya a little more, and in the villages of Bekâa one-twelfth. This difference is accounted for by the fact that the yield of eggs is by no means the same in all localities in which the silk industry is engaged in, on account of the greater or smaller amount of care and attention bestowed by the breeders—for the climate is favourable throughout the country. Attempts have frequently been made at the production of native eggs, but they have invariably been unsuccessful. This is generally attributed to the following causes. That the choice of the worms is made without due care and attention; that the eggs are not examined microscopically; the colour and dimensions of the cocoons are mixed, and the eggs are not preserved until the moment of incubation, in favourable places. In Syria the weaving of silk is as old as the cultivation of the raw material itself. The brilliant period however which this industry once enjoyed in Europe, Asia, and Africa has long gone by. The silk weavers of the present day work principally for domestic production. The native manufacturers have had much to contend with from foreign competition, which made itself severely felt, and markets that were formerly controlled by Syrians are now disputed by European manufacturers, who with their skilled artisans and with the aid of improved machinery find competition with the older methods comparatively easy. The greatest specialty in the native silk stuffs, and in which Syria undoubtedly excels, is that in which

cotton forms the warp, and in which the greater or lesser quantity of silk in the weft determines the quality. The principal silk manufactures are the *Kaffiehs*, or headdresses, *Aboyas*, or Syrian cloaks, shawls, tobacco pouches, slippers, pillowcases, stuffs for dress goods, and stuffs for upholstery.

THE PRODUCTION OF CAMEMBERT CHEESE.

The popular small cheeses made in France and Germany but used everywhere, being largely exported from these countries, are divided into two classes—one is used within a few days after the making, the other being cured for later consumpton. It is plain that the latter description of cheese is more suitable for extensive manufacture on this account than the older kind, known as *fromage frais*, and, on account of the greatly improved quality, the cured ones are known as *fromage fin*. This term is fully justified by the most careful process of curing by which the sharper ammoniacal taste and odour are got rid of, and a soft, rich, buttery consistence and a pronounced and pleasant flavour are given by the slow and careful curing. It is a noteworthy fact that this method of curing which has been in use for more than a century and has been slowly evolved by gradual experience, is based on the most correct scientific principles. A typical cheese of the cured kind is the Camembert, so-called from the place of its original manufacture, where it was first made in the year 1791 by a dairyman named Peynel. The manufacture now amounts to several millions of cheeses annually, and employs the whole population of this district. The method of manufacture of this popular cheese is exceedingly delicate and demands the greatest care in the most minute details, beginning with the milking of the cows—indeed before this, for the feeding and lodging of them are fully considered in respect of the avoiding of everything that might interfere with the perfect purity of the milk, and the preservation of all the fine qualities of the pasture of this especially-favoured district. This extreme care accompanies all the work in the dairy until the milk is finally and carefully strained. The milk having been drawn, is strained immediately, and is set apart for three hours for the cream to rise. There is then a thin pellicle of cream on the milk, which is removed and churned into a very fine quality of butter. The milk, for the convenience of the special manipulation, is set in broad earthen jars, each holding five or six gallons, and, as each has been skimmed, it is set on a heater and warmed until the common well-known pellicle or skin forms on the surface and wrinkles or creeps as it is called. The temperature at which this happens is somewhat over 100 degrees. The rennet is then added, one table spoonful to each jar of milk, in which there are twenty litres equal to about twenty-one quarts. The rather high temperature of the milk when the rennet is added brings the curd quickly, and at the end of five or six hours each jar is set on a low bench, in a sloping direction so as to bring the contents to the extreme edge, and the curd is then dipped out into the moulds which are of cylindrical shape. These moulds, made of pure tin, are twelve centimetres or four and three-quarters inches high and wide. They are open at each end and are set on mats of rushes sown together. The moulds are filled with the curd, from which the whey drains through the rushes on to the sloping table, around which a groove is cut to carry it to the drain by which it flows away. As the whey drains from the curd this shrinks in volume until the cheese has gained sufficient consistency to be handled out of the mould, which is at the end of the second day. They are then taken out of the moulds and sprinkled with salt, and left on the mats three or four days longer. They are then placed in shallow wooden boxes with handles, and are in this way removed to the drying room. Here they are arranged on frames, of which there are several tiers, and are exposed to a free circulation of air regulated by swinging shutters. These windows are not glazed, but they are protected by fine wire gauze to keep out the flies, and, as the direction of the wind varies so the shutters are opened or closed fully or partially in such a manner as to direct the air currents over or under the cheeses lying on the lathed frames, through which the air has complete access to the cheeses. Here they remain from twenty to twenty-five days according to the weather. They are then removed on large movable shelves to the curing cellar, where the circulation of the air is much increased by the management of windows similar to those previously described and the shutters fitted to them. At this time the fermentation in the cheese begins to throw off moisture which gathers on the surface of the cheese. At this stage the cheeses are removed to the finishing cellar, in which the windows are glazed and protected by inside blinds. In this place the cheeses remain a month or less as the ripening may progress slowly or rapidly. During this time they are turned once in forty-eight hours. This constant turning is a special process for the fullest exposure of the cheeses to the air, and is practised all through the curing, gradually increasing the time of the turnings if the ripenings may be proceeding too quickly. At the end of the term the cheeses are complete, and are packed in paper and put into boxes. They are then packed into wicker baskets and sent to market. They weigh about eight ounces, and sell for about one shilling and sixpence each. The finest selected cheeses are sent to special customers who pay one-fourth more. The prices vary as the season, or the demand and supply, but usually they remain about the same for years. Such a desirable cheese as the Camembert is of course imitated and sold at at a less price, but on account of the strict way the French Government has of controlling such things, the imitation is sold for what it really is, as *fromage façon Camembert*, which does not deceive the purchaser in any way.

Correspondence.

LIGHT RAILWAYS.

Mr. Robert J. Money writes:—The most important factor of economy is the question of speed. This was recognised by the Italian Government Commission, which, in 1879, when Italy was exercised in the same way as England is now, sat to consider what economies could be effected in the construction of railways. Three types of economical standard gauge lines were recommended, distinguished essentially by the maximum speed allowed, as follows:—Type 1, 25 miles per hour; type 2, 18½ miles per hour; type 3, 12½ miles per hour. Type 1 was to be adopted for lines situated between main lines, to have the same standard of permanent way as the main lines, but a cheaper road bed, sharper curves, and steeper gradients. Rolling stock of the same type as main lines, except locomotives built for great speed, or with a long rigid wheel base. Type 2 to be adopted for lines branching off the main lines, or of secondary importance. Permanent way to be lighter, road bed cheaper, curves sharper, and gradients steeper than Type 1. To be worked with special rolling stock, but constructed to allow of the passage of main line carriages and goods waggons. Type 3, specially applicable to those lines on which the chief traffic is in goods. Permanent way to be lighter, road bed cheaper, curves sharper, and gradients steeper than Type 2. To be worked with special rolling stock, but constructed to allow of the passage of main line goods wagons. The Italian law provides "that lines which cannot form part of a main line system are to be built as economically as possible." No Government could be more careful of life, or issue more stringent regulations for the safety of passengers and the public, than the Italian; this, however, does not prevent their having light railways, in many places entirely unfenced, and in others, separated only from the highway by a light barrier or low stone wall. Fixed signals are only required in special cases. As a railway manager, I quite agree with the author of the paper, that a light railway costs more to work per unit of traffic than a line of large traffic. As an instance, on the Palermo-Corleone Railway, in Sicily, 40 miles in length, with a small traffic, and two trains each way per day, besides work and special trains, the same general management, station, and permanent way staff, could have worked three times the traffic, or six trains each way per day, the only increase would have been in drivers, firemen, guards, brakemen, and workshop *employés*. Also, the steeper gradients and sharper curves adopted on light lines, while reducing the first cost of construction, increase the working expenses, owing to increased fuel consumption, and wear and tear of rails and rolling stock. I wish also to confirm Mr. Acworth's remarks as to the necessity for higher rates on light railways of limited traffic. On the above narrow gauge railway, with a traffic of £5 10s. per mile per week, the Italian Government, when it was opened in 1888, applied the tariff in force on the main lines of standard gauge. This was found quite unsuitable, and after an experience of five years' working, we drew up a new tariff of higher rates, which, although strongly opposed by all the local authorities, was eventually accepted by the Government, who saw the force of our remarks and the truth of our statistics.

Mr. P. W. Meik writes:—I compliment Mr. Acworth on his valuable paper, with which I am quite in accord. The important point to keep before the public and the Press is that if light railways are to be made, we must have more liberty. The English race owes its supremacy to freedom, and has never taken kindly to "grandmotherly" legislation. Attempts to regulate trade, commerce, or manufactures by Act of Parliament are always risky, and restrictions tending to discourage private enterprise should be adopted with extreme caution. What may be the provisions of the Bill which is to be the outcome of the Board of Trade Conference we can, as yet, only conjecture, but I venture to hope that it will take entirely the direction of more freedom. It will be of little benefit if, while removing restrictions in one direction, it hampers business enterprise by attempts to define or recommend any particular type of line, or to impose new financial regulations. If, as is to be hoped, future legislation avoids the imposition of new fetters, it will be open to Mr. Carruthers Wain to construct the particular type of line which he advocates, but I am afraid he will not make much progress if he expects a Government or local guarantee. I do not agree with him at all when he says that without a subsidy or guarantee of some sort no new light lines will be made. I, myself, know several lines which will be made at once if the regulations of the Board of Trade are relaxed as suggested by the Committee. Mr. Carruthers Wain's argument that such lines would have been made in the past if they were worth making by private enterprise, overlooks entirely the saving which will be effected both in cost of construction and in working, if the recommendations of the Board of Trade Committee are adopted. The saving in first cost may be assumed as from £1,500 to £2,000 a mile, and the saving in working expenses at from £1 to £1 10s. per mile per week, together making a minimum £2 per mile per week, or enough to make all the difference between profit and loss. There is, in my opinion, nothing to be gained by following Mr. Price Williams into the region of absolute cost. The cost of a light line may be anything, from the overland route quoted by Sir Benjamin Baker at £600 to £1,000 per mile up to the cost of an ordinary existing branch line. It entirely depends upon what sort of a line we have to make, and it will be time enough to discuss the question of cost when we know how far we are to be allowed to modify the present standard.

Obituary.

Thomas Twining.—Mr. Thomas Twining, one of the oldest members of the Society of Arts (he was elected in 1847), died on Saturday last, 16th inst. He was a member of the Council from 1851 to 1859, and a Vice-President from 1862 to 1873, during which period he took an active part in the work of the Society. Mr. Twining was born at St. Faith's, near Norwich, in 1806. From boyhood he had been much of an invalid. In 1823 his eyesight was impaired by exposure in Switzerland, and in 1825 the effects of a fall on the ice at Milan, necessitated the use of crutches for the rest of his life. In spite of these bodily infirmities, Mr. Twining was most energetic in his attempts to improve the instruction of the working-classes, and, before 1849, he had endeavoured to establish a technical college for artisans. In 1855, he reported to the Council of the Society of Arts on "Special Collections of Articles of Domestic and Sanitary Economy for the Working Classes," and soon afterwards he superintended the collection by the Society (see *Journal*, vol. iii. p. 675) of models, drawings, &c., for an Economic Museum. A portion of these collections was, in 1857, handed to the South Kensington Museum, subsequent collections were lent to the Polytechnic Institution, and in 1860, Mr. Twining founded his own Economic Museum at Twickenham; this, unfortunately, was burnt in 1871. The Economic Gallery, which attracted much attention at the Paris Exhibition of 1855, was due to the movement of the Society, initiated by Mr. Twining. The Emperor Napoleon III. and the Empress Eugénie took great interest in the scheme, which was carried out under the superintendence of Prince Napoleon. Mr. Twining brought out in 1874, in conjunction with Mr. J. Scott Russell, a work entitled "Technical Training," which embodied the results of his studies of industrial life, and was an early contribution to the now very extensive literature connected with Technical Instruction. In connection with his Economic Museum, and as a help towards the wide dissemination of its teachings, he planned a series of illustrated lectures on elementary science, which he published under the title of "Science made Easy," and which has been largely used at various institutions about the country for the purpose of spreading a knowledge of the science of common life. Besides these two works, Mr. Twining published many pamphlets and reports on the subjects in which he was so greatly interested. He received the Cross of the Legion of Honour from Napoleon III. in 1855, and the Order of SS. Maurizio e Lazaro from the Italian Government in 1867, besides medals at various exhibitions.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock:—

February 27.—"Furnaces for Roasting Gold-bearing Ores." By C. G. Warnford Lock. W. C. Roberts-Austen, C.B., F.R.S,, in the chair.

March 6.—"Cider." By C. W. Radcliffe Cooke, M.P. Sir George Birdwood, K.C.I.E., will preside.

March 13.—"Our Food Supply from Australasia." By E. Montague Nelson. Sir Frederick Bramwell, Bart., D.C.L., F.R.S., will preside.

March 20.—"The Progress of the Abattoir System in England." By H. F. Lester, Hon. Secretary to the London Model Abattoir Society. Sir Benjamin W. Richardson, M.D., F.R.S., will preside.

March 27.—"Modern Photogravure Methods." By Horace Wilmer.

April 3.—"Sand Blast Processes." By John J. Holtzapffel.

Papers the dates of which are not fixed:—

"The Use of Aluminium in the Separation of Metals from their Oxides." By Professor William Chandler Roberts-Austen, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. Charleton, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. Crompton, M.I.E.E.

"Electric Lighting of Ecclesiastical Buildings." By Major-General Charles E. Webber, C.B.

"Improvements in Milling Machinery." By J. Harrison Carter.

"Deviations of the Compass." By Professor A. W. Reinold, F.R.S.

"Means for Mitigating the Fading of Pigments." By Captain W. de W. Abney., C.B., F.R.S.

Afternoon Lecture.

Thursday, March 14, at Half-past Four.—"Art Tuition." By Prof. Hubert Herkomer, R.A.

Indian Section.

Thursday Afternoons, at Half-past Four o'clock:—

March 28.—"Chitral and the States of the Hindu Kush." By Capt. F. E. Younghusband, C.I.E. The Hon. George Curzon, M.P., will preside.

April 25.—"The Coming Railways of India, and their Prospects." By J. W. Parry, A.M.Inst.C.E., late Executive Engineer Indian State Railways.

May 23.—"Punjab Irrigation: Ancient and Modern." By Sir James Broadwood Lyall, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 5.—"Colonies and Treaties." By SIR CHARLES M. KENNEDY, K.C.M.G., C.B.

APRIL 2.—"Commercial Education in Belgium." By PROFESSOR WILLIAM LAYTON.

APRIL 30.—"Madagascar." By CAPTAIN S. PASFIELD OLIVER.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

FEBRUARY 26.—"Mediæval Embroidery." By MISS MAY MORRIS. ALAN S. COLE will preside.

MARCH 19.—"Carpet Designing." By ALEXANDER MILLAR. J. HUNGERFORD POLLEN will preside.

APRIL 23.—"Art of Casting Bronze and Copper in Japan." By WILLIAM GOWLAND. PROF. W. C. ROBERTS-AUSTEN, C.B., F.R.S., will preside.

MAY 7.—"Recent Improvements in Designing, Colouring, and Manufacture of British Silk." By THOMAS WARDLE.

MAY 28.—"The Decoration of St. Paul's." By PROF. W. B. RICHMOND, A.R.A.

CANTOR LECTURES.

Monday Afternoons, at Four o'clock :—

ALAN S. COLE, "Means for verifying Ancient Embroideries and Laces." Three Lectures.

FEBRUARY 25. — LECTURE III. — Lace — Its development from twisting, plaiting, and looping threads together into ornament—Early instances of simple nets for useful purposes only (Assyrian and Egypto-Roman)—Absence of suggestions of lace until about Sixteenth Century A.D. — Gradual changes in the texture and dimensions of laces from Sixteenth to Eighteenth Centuries—Specimens of the different sorts compared with laces, indicated in portraits.

*** Mr. Cole's lectures will be delivered in the afternoon, at Four o'clock.

DR. D. MORRIS, C.M.G., "Commercial Fibres." Three Lectures.

March 18, 25, April 1.

JAMES DOUGLAS, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures.

April 22, 29, May 6, 13.

ERNEST HART, D.C.L., "Japanese Art Industries." Two Lectures.

May, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. (Cantor Lectures.) Mr. Alan S. Cole, "Means for Verifying Ancient Embroideries and Laces." (Lecture III.)

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Sir Douglas Galton, "Ventilation, Warming, and Lighting."

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Mr. Henry Illingworth, "Past and Present Methods of Educating the Blind."

Imperial Institute, South Kensington, S.W., 8½ p.m. Captain E. R. Hills, "Photography in its Application to Astronomy."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Sir William Macgregor, "British New Guinea."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. J. Packham, "A New Method of Toning Platinotype."

London Institution, Finsbury-circus, E.C., 5 p.m. Sir F. Seymour Haden, "Rembrandt and His Work."

TUESDAY, FEB. 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Miss May Morris, "Mediæval Embroidery."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "Internal Framework of Plants and Animals." (Lecture VII.)

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. Herbert Manley, "Sanitary Law—English, Scotch, and Irish."

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Mr. J. W. Gifford, "The Correct Rendering of Colours in Black and White."

WEDNESDAY, FEB. 27 ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. C. G. Warnford Lock, "Furnaces for Roasting Gold-Bearing Ores."

THURSDAY, FEB 28...Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. Andrew Pringle, "The Reproductions by Photography of the Microscopic Image."

London Institution, Finsbury-circus, E.C., 6 p.m. Rev. Dr. Dallinger, "The Beautiful, as seen in Minute Nature."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. L. Fletcher, "Meteorites." (Lecture III.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. W. B. Sayers' paper, "Reversible Regenerative Armatures, and Short Air Space Dynamos."

Civil and Mechanical Engineers, 12, Delahay-street, Westminster, S.W., 7 p.m. Mr. A. S. E. Ackerman, "Machinery for Testing the Strength of Materials."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Gleeson White, "The Life Model."

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Sir William Macgregor, "British New Guinea."

FRIDAY, MARCH 1.—Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Rev. Canon Ainger, "Children's Books of a Hundred Years Ago."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Prof. Wynter Blyth, "The Law relating to the Supervision of Food Supply."

SATURDAY, MARCH 2...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Light."

Journal of the Society of Arts.

No. 2,206. Vol. XLIII.

FRIDAY, MARCH 1, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday afternoon, 25th inst., Mr. ALAN S. COLE delivered the third and last lecture of his course on "Means for verifying Ancient Embroideries and Laces."

Major-General Sir JOHN DONNELLY, K.C.B., Chairman of Council, proposed a vote of thanks to the lecturer for his valuable course of lectures, which was carried unanimously.

The lectures will be printed in the *Journal* during the summer recess.

PRIZES FOR DESIGN FOR A SILVER CUP.

The Council of the Society offered a prize of £25 for the best design for a silver cup; the design, if adopted, to be used for the Swiney cup. Competing designs were to be sent in not later than the 31st December, 1894. A large number of models and drawings were sent in response to this offer, but the Council do not consider any of the designs to be worthy of the full prize offered. They have, however, in accordance with the report of the Committee, to whom the designs were referred, divided the amount of the prize among the following competitors, whose works they consider the most deserving:—

W. Amor Fenn—a Prize of Ten Guineas.
Eleanor L. Mercer—a Prize of Seven Guineas.
T. J. Overnell—a Prize of Five Guineas.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, February 19th, 1895; FRANCIS COBB, Treasurer of the Society, in the chair.

The CHAIRMAN informed the meeting that Lieut.-General Sir Andrew Clarke, who was announced to preside on that evening, was, to his great regret, unable to be present on account of illness.

The paper read was—

THE REPUBLIC OF PARAGUAY.

By ALEXANDER F. BAILLIE,
Consul in London for the Republic.

I fear that I may be charged with presumption in venturing to address the members of this Society in relation to a country where arts are imperfect, manufactures are few, and commerce is stagnant; but your Society was chiefly formed for the encouragement of arts and manufactures, and I am animated with the hope that the paper I am about to read may induce you to regard with favour the remote Republic of Paraguay, and to lend your aid in the development of its latent resources.

It is an inland State of South America, of which the area is estimated to amount to 142,000 square miles—a territory of much greater magnitude than Great Britain and Ireland—but a large portion is still unexplored.

It is situated on both sides of the River Paraguay; the portion on the left bank being a well-defined area lying between the Apa and the Parana, but the Gran Chaco on the right bank has no well-defined limitation from the neighbouring Republic of Bolivia.

The capital is Asuncion, or more correctly, "the City of the Assumption of the Blessed Virgin," in whose honour it was founded by Don Juan de Ayolas in 1536. Asuncion is distant about 26 days' journey from this country, 22 of which are occupied by the ocean voyage to Montevideo or Buenos Ayres, great cities at the mouth of the River Plate, and four in ascending 1,000 miles of the Parana and Paraguay rivers. It has a population of 25,000 inhabitants and is a neat and pleasant city with a cathedral and several fine parochial churches, and public buildings. It is the terminus of a railway 150 miles in length, and possesses several tramways.

The neighbouring States are Bolivia, Brazil, and Argentina; but of these, in former times, Paraguay included a large portion, and in the 16th century it was spoken of at the Court of the Emperor Charles V. as "the gigantic province of the Indies." It was well entitled to some distinctive appellation, for, nominally, it embraced one-fifth of the whole of South America, and included Bolivia, Tucuman, part

of Brazil, and the whole of the southern part of the continent.

History assigns to Juan Diaz de Solis, Grand Pilot of Castile, the honour of having discovered the magnificent harbour of Rio de Janeiro and the great river or estuary now known as the Rio de la Plata, but which he named the Rio de Solis. His discovery added to the Spanish Crown the vast area now called the Argentine and Uruguayan Republics, but unhappily he never reaped any reward, for, falling into an Indian ambush, he was killed and eaten. Posthumous honours were accorded to him, and in Buenos Ayres we have a "Calle de Solis," and in Montevideo a magnificent opera-house called the Teatro de Solis. His unfortunate expedition was followed by that of Fernando de Magalhaens, whose name still survives in the Straits of Magellan. He sailed up the Rio de Solis for some distance in the hope that it would afford the passage through the mainland, of which he, like all the early navigators, was in search; but, finding that the river grew shallow and the waters fresh, he retraced his steps and continued his course in a southerly direction. Magalhaens, or Magellan, was killed in the Phillipine Islands, but one of his vessels, the famous ship *La Victoria*, after an absence of three years, during which she had sailed round the world, returned to Spain laden with spices and other precious commodities from the Southern Pacific.

Her success induced some merchants of Seville to fit out a fleet at their own expense designed to search for "Tharsis, Ophir, and Cipayo," which were supposed to be the islands of Japan, and they offered the command of the expedition to an able navigator named Sebastian Gabotto.

Sebastian Gabotto, or Cabot as he is known in history, has these claims to the attention of the English public: that, although of Venetian parentage, he was born in Bristol about 1477, that he served under three English kings—the seventh and eighth Henrys, and Edward the Sixth—that by his discoveries in North America he added greatly to the territories of the Crown, and that he laid the foundation of Great Britain's maritime power. His English biographer has written of him: "He gave a continent to England, yet no one can point to the five feet of earth she has allowed him in return." His name survives in several places in Hudson Bay and its neighbourhood, and a world-famed book repository in the city of Bristol still bears the sign of "Cabot's Head."

He was appointed by the Emperor, Captain-General of a small squadron which left Europe in 1526, and arrived in the Rio de Solis in the following year. Cabot was more successful than his predecessors, and we find that in March, 1528, he had ascended the Parana and reached the mouth of the Vermejo which flows into the Paraguay. Unquestionably Cabot was the first European who reached Paraguay by water, and I would willingly accord to this gallant English adventurer the honour of its discovery, but certainly one other European had already visited the country. The news of Pizarro's great conquest of Peru had been spread far and wide, and at length had reached the Portuguese settlements in Brazil. The Governor-General of that country, desirous of getting for his own Government a share of the immense riches that, according to report, had been discovered, dispatched a pioneer, Alexis de Garcia, to reconnoitre an overland route. Garcia with a body of Indians advanced towards Peru, probably into Bolivia, and there collected some gold and a large quantity of silver, with which he commenced his return journey. When recrossing the Paraguay he was killed, and his booty was captured by Indians, who in their turn were defeated by Cabot, and the precious metal that Garcia had amassed fell into his possession.

At that time Cabot knew nothing about his European predecessor, and imagined that the riches he had acquired were the produce of mines in the immediate neighbourhood of the great rivers that he had mounted, and he therefore sent them home to the Emperor as samples of the wealth of the country that he had discovered. The incident is not without a certain topographical interest, for in the pride of conquest and acquisition of large treasure, Cabot changed the name of the "Rio de Solis," and gave it that of the "Rio de la Plata," or "Silver River," a title which it has ever since borne, but which is a great misnomer, for the Plate is not a river—it is simply the mouth of the Parana and the Uruguay; and silver has never been discovered within some hundreds of miles of its banks.

Cabot was succeeded by Don Pedro de Mendoza, a courtier of good family and of some wealth, who fitted out an expedition at his own expense, which reached the River Plate about the beginning of 1535. In that same year, his second in command, Juan de Ayolas, was despatched up the River Paraguay with a force of 300 men. Owing to the tortuous character of the river, nearly twelve

months elapsed before the expedition reached the position where Asuncion now stands, and there it encountered and defeated with great loss an army of Indians. The name of the unfortunate *cacique* or chief who opposed on that occasion the advancing Spaniards is still preserved in the "Cerro or Peak of Lambaré," which, clothed with tropical verdure from the water-level to its pinnacle, stands like a gigantic herald to welcome the arrival of visitors to the most ancient city in the River Plate districts, and which became the great centre of Spanish domination. Thence started numerous expeditions to effect new conquests and to found new colonies, and the present cities of Buenos Ayres, of Santa Fé, and other places on the borders of the Parana and Uruguay, owe their permanent foundations and are indebted for their existence to the Spanish adventurers who first settled in Paraguay.

We have now reached a point at which the history of modern Paraguay commences; the era in which it was withdrawn from its existence as a collection of savage tribes of South America, and was brought by degrees under the control and dominion of a civilised monarchy of Europe. The people over whom the Spaniards came to dominate consisted of many different tribes, speaking diverse languages; but there was one race more widely diffused than any other, the great Guarani family, which occupied the eastern side of the Andes, from the Amazon to the River Plate. It included several nations, differing greatly in their characteristics, and these were very remarkable even in tribes or nations only separated by a swift flowing river. For example, the people on the left or eastern bank of the Paraguay—that is to say of Paraguay proper—were pure Guaranis, of a mild disposition, inclined to agricultural pursuits, and neither ferocious nor warlike, yet at the same time possessing abundant courage, and capable of being trained as fighting men, as was proved by their conduct under the leadership of their Spanish officers, and at a much later period by their prolonged resistance to the allied forces of Brazil and the Uruguayan and Argentine Republics in the war of 1865 to 1870.

On the other or western side of the river there were several tribes whose chief business in life was warfare, and of these the more remarkable were the Payaguas and the Guaycurus, who were exceedingly savage and constantly making raids across the water. The remnants of the Payaguas at the present day have still very distinctive features from those of the Guaranis—a remarkable pointedness of the top of the skull, and teeth very large, hard set, and pointed like a jaguar's, made to tear and not to masticate. They live by hunting and fishing, and are just as savage and intractable as their forefathers, who harried their neighbours and showed a brave front to the conquering Spaniards.

As regards the habits, organisation, and religious belief of the Guaranis, very little information is to be had even from the oldest writers. The men were nearly naked, but adorned themselves with girdles and head-dresses of many-coloured feathers; the women wore the "tipóy," or smock, ornamented with hand-made lace, which is still their principal garment in the present day. The arms of the hunters and warriors were spears and bows and arrows, the points being made of fish-bones, for the use of iron was not known among them, although it existed in the country.

In respect to the religion of the natives, old Spanish writers have called them idolaters, but that word was usually attached to anyone not professing the Christian faith. If the word be used in its meaning of worshipping idols and graven images, it does not apply to the aborigines whom the Spaniards found in Paraguay and the Chaco. The symbolising of religion—the reduction of the Divine Being into images of metal, or wood or stone—is by no means common among savages. The practice belongs to people of much higher state of cultivation than the inhabitants of the River Plate possessed at the time of the conquest. In Peru, Ecuador, Venezuela, Yucatan, and part of Brazil temples and idols have frequently been discovered, but amongst the savage and wild tribes bordering on the Paraguay and the Parana no mention has been made of sacred relics or hallowed places. And yet the natives of those districts, like every other people of the world, had an incipient, but undefined faith.

One universal religion seems to have spread all over the continent of South America, namely, the worship of the sun and of other heavenly bodies. The Incas of Peru, "the Children of the Sun," during the whole period that their dynasties lasted, carried on a sacred war, a crusade, to spread this religion, and wherever their arms were successful, and they generally were successful until the advent of the Spaniards, they imposed upon the conquered the adoption of their own faith. Their

banners never fluttered over the Parana, but the fame of the "Children of the Sun" reached the surrounding districts, and the casual intercourse that unquestionably existed between the eastern and western coasts diffused among the savages a knowledge of Cuzco, "the Peruvian Mecca," and its magnificent temples.

That religion is not yet entirely dead, for to this day, amongst the remnants of the aborigines of the Gran Chaco, and probably too amongst other Indians, the Good Spirit is in the ascendant when calm and sunshine prevail, while the Evil Spirit is to be dreaded when storm and tempest are threatening. But if the religion of the sun is now confined to a comparatively small area, not so its symbols. From Panama to Patagonia, from the Pacific to the Atlantic, on almost every national banner is blazoned the sun rising, the sun setting, or the sun in all his glory; just as the crosses of Champions of Christendom, of St. George, St. Andrew, and St. James, form the main features of the ensigns of European nationalities. I will not venture to connect the eminent Christianity of Northern America with the religion of the Incas, but nevertheless it is a fact that a considerable number of the luminous bodies seen in the heavens, are mingled with the stripes, in the star-spangled banner of the United States.

The history of Paraguay under the Spanish "adelantados" or governors, who followed one after another in quick succession; of their lieutenants and subaltern officers; is by no means edifying, and a very cursory reference to their deeds, sometimes valiant, but oftentimes criminal, will suffice to connect the Spanish domination with the Declaration of Independence. One or two names may be mentioned, as those of governors, who upheld their country's honour, such as that of Don Domingo de Irala, who brought the colony into something like order, and to whom is largely due the assimilation of the conquerors and the conquered, for he encouraged the contraction of marriages between Spaniards and Guaramis, and introduced some sort of morality.

Alonzo Nuñez Cabeza de Yaca was deposed by his officers chiefly on account of the protection that he afforded to the unfortunate Indians, against the tyranny and cruelty of his subalterns, and is a bright exception to the list of avaricious and oppressive governors, one of whom, Luis de Cespedes (1634), is stated to have sold to the Portuguese into slavery 60,000 natives in the short period of two years.

It is remarkable how excessively and unnecessarily costly in the sacrifice of life and property has been the spread of the Christian religion—the religion of peace—throughout all ages, whether in Palestine, Peru, or Paraguay; and nowhere is it more noticeable than in its introduction into the latter.

In Paraguay, no idea seems to have been entertained, for a century at least after the conquest, of introducing amongst the natives any of those advantages or improvements which the higher civilisation of the invaders could have afforded. They found a number of tribes friendly and tractable, but far from encouraging them to cultivate the soil or to enter into trade, they extorted everything that the unfortunate people possessed.

Not content with the acquisition of wealth and territory and supreme power, the Christian warriors who conquered the country had no pity for the vanquished. They seized or burned the roof that covered them; they tore the rings from the man's ears and the ornamental comb from the woman's hair; they enrolled the males into companies, and carried them away to search for gold at vast distances from their homes, and they sold the women into slavery.

My sketch is not exaggerated—it is cold and colourless when compared with the pictures painted by the governors of Paraguay themselves, one of whom, Hernando de Saavedra, made the discovery in 1608, seventy years after the first conquest, that with all the forces at his command it would be impossible to vanquish the aborigines with the sword, and suggested that it would be well to try and subdue them by the propagation of the true faith. Philip the Third of Spain, a contemporary of James the First of England, adopted that suggestion, and by a royal decree placed the spiritual interests of the natives under the care of the disciples of Ignatius Loyola.

We arrive at an episode in the history of Paraguay which has attracted a good deal of attention, and given employment to the pen of such distinguished writers as Raynal Montesquieu, Robertson, Charlevoix, Southey, and others. The idea has obtained that the great religious institution founded by Loyola gained a footing in a country called Paraguay, and there administered for a long period of years a sort of paternal government, both spiritual and temporal, over the vast colonies created by Spain, and almost independently of the monarch of that country. Of course there is a basis of fact, and the story of the

Jesuit domination in South America is so marvellous in itself that there was never any necessity to spin around it a web of romance and exaggeration; and perhaps now, upwards of 125 years since that domination ceased, we may be permitted calmly and briefly to consider the influence extended to Paraguay, and the permanent marks of civilisation impressed upon that country during the remarkable period of its partial government by a handful of the most disciplined and enlightened missionaries that the world has ever produced.

The pioneers of the society—authorised by Philip III.—reached Asuncion in 1690, and were quickly followed by other members. In that city they never attained to any power; they quarrelled with the Bishop, and they could not accommodate themselves with the local political authorities; but they founded several colleges and religious houses in the diocese, and they ultimately established their renowned administration in the south-eastern extremity of Paraguay, a district which is still called "The Misiones." There their authority was paramount. They maintained a semblance of respect for the King, but they would not admit even his governors and bishops within the territory over which they ruled unless they were well assured that the disposition of those dignitaries was friendly, and that they would render a favourable report of everything that should come under their inspection.

The government of the Misiones was an autocratic oligarchy; the Superiors and Brothers were supreme, and below them all were subjects, without any grades of rank or position except such as might be conferred upon them by the Fathers for the better administration of the different communities. These communities were entirely cut off from the rest of Paraguay, and only held intercourse with one another by special permission of the governing powers. They were confined to *reducciones* or camps surrounded by deep broad moats, which served as a means of defence against the attacks of the *Mamelukes* or outlaws and runaway slaves from the neighbouring Brazilian settlements, and also prevented ingress or exit, except at special points, to the members of the community.

The propagation of Christianity amongst the heathen and infidels is not the first object of the Society of Jesus, but only the fourth in their code. The education of youth takes precedence of all other purposes, and it was much more in the light of children than of infidels that the Indians of Paraguay were regarded by the Order. The holy Fathers set to work in their own way to educate a multitude of people, adults in point of age, but children in mind and thought; a people tractable and easily led, with no deep immoral propensities, and with no marked religious tendencies. Of agricultural and pastoral habits, and only nomadic so far as the requirements of their herds necessitated a change of ground, the Guaranis were a class of Indians on whose barren minds it was not difficult to make an impression through the eye and the ear, and whose wanderings could easily be confined within certain limits.

It was through the ear and the eye that the attack was insiduously but successfully made. Music seductive and novel, hymns and songs of praise simple and rhythmical, although in a foreign tongue, indulged and gratified the sense of hearing; while the gaze of the spectators, accustomed only to the sombre hues of the dense primeval forest, was fixed intently on the brilliant colouring and gorgeous vestments displayed in the performance of the rites and ceremonies of the Catholic Apostolic Church. The sad story of the Holy Virgin and her Blessed Son was told in all its beautiful simplicity, but no doctrine was derived from it; and, in fact, the Fathers confess their inability to expatiate at any length on the principles of their own religion, in consequence of the difficulty they encountered in mastering the language of their disciples, and in finding suitable interpreters.

But their object was attained; the simple natives followed like sheep their pastors; to the sound of music they marched to their daily labour, and to the sound of music they returned from the fields, to attend a religious service, of which they did not understand one single word, before seeking their well-earned repose.

Morally, the Jesuits left their impress upon that portion of the inhabitants of Paraguay over whom they dominated for 150 years, but whether that impress was of permanent benefit to their subjects, socially and commercially, is a question that has given rise to a good deal of controversy.

The adventurers who took possession of Paraguay, and who founded the great colony of which Assumption was the centre, were Andaluzes, from that fertile and picturesque province in the sunny south of Spain, which contains the cities of Cordova, Sevilla, and

Granada, around which were concentrated the romance, the chivalry, and the barbarities of European warfare in the middle ages. To Paraguay—the country won at the point of the sword—they brought their Moorish blood, their dark complexions, their black eyes, their stalwart figures, and their symmetrical and well-formed hands and feet. They were unencumbered with wives, and they promptly formed alliances with the native women, at first illicit, but, in course of time, a more moral feeling predominated, and the Old World became joined to the New by the sacred bonds of matrimony.

From these alliances sprang a race in Paraguay proper, equal, if not superior, to that of the conquerors. To the quiet innate gentleness of the Indian mother were added many of the inherent qualities of the European progenitors—the quick wit, the ready repartee, the love of gaudy colours, and perhaps, too, the jealousy and suspicion that are still characteristic of the Andaluz and the Paraguayan.

The harmonious sounds of the guitar were heard in every corner; the graceful dances of Spain were introduced into every house, and at length the stalwart conquerors confessed to a re-conquest, and adopted the very language of the vanquished. Spanish was the language of the Court, but Guarani was that of the people.

On the other, the eastern side of Paraguay, where the disciples of Loyola administered their paternal government, the picture was very different. Separation from the outside world was rigidly enforced; admission to the trader to display his European goods and to barter them for native produce was strictly prohibited; and the Fathers took good care that the communities under their charge should never be contaminated by the presence of the Spanish adventurers. No cavalier was ever permitted to disturb the rest of the Guarani maiden with his moonlight serenade; her sight was never attracted to his gallant barb, his nodding plumes, his gay vestments, and his clanking spurs; and her thoughts were never distracted by the soft, seductive words of a lover from over the sea. The Indian lass was kept secluded in the reducciones, and, in due course, was mated with one of her own people, selected by her spiritual advisers.

What has been the result? The Indian of the Misiones is to this day a simple, unadulterated Indian, tractable and obedient, in accordance with the training of his former masters, but also taciturn and morose, the natural result of that system of training. The sprightliness, the gaiety, the upright figure, the small hand and foot of the woman on the banks of the Paraguay, which were derived from her Ibero-Moorish progenitors, are all alike wanting in her sister whose home stands above the turbulent waters of the Parana, and whose forefathers were disciples of the Jesuit missionaries.

It is certainly marvellous that a handful of English, Irish, Flemish, and Italian priests should have been able to keep in subjection for 150 years thousands of natives, who, immediately after the expulsion of their masters in 1768, displayed their love of freedom and liberty by deserting the Reductions, and other communities, and returning to their native wilds; and the fact that the successors of the Jesuits, a mixed body of religious and civilian officials, entirely failed to maintain anything like order, goes to prove that the disciples of Loyola possessed exceptional administrative capacities; but it also proves that their long domination had not created any great fondness in the hearts of their subjects for a semi-civilised life in villages and societies.

Within fifty years from the expulsion of the Jesuit Fathers, half of those villages had ceased to exist, and at the end of a hundred years only one has remained occupied throughout Paraguay. But there is a business feature in this extraordinary administration, which may well be submitted to a Society created for the encouragement of commerce, and which may also account in some degree for the distaste of the Indians to a life of discipline and labour.

It is, perhaps, time that the current idea, founded on the authority of several writers, to whom I have already referred, "that the Jesuit Fathers carried on their paternal government solely for the benefit of a community, the produce of whose common labour provided for the wants of all," should be dissipated. That is the idea that recently induced a number of men and women of an adventurous nature, and to some extent discontented with their actual existence, to abandon the British Colony of New South Wales, and to risk the perils of Cape Horn, in order to seek an elysium in Paraguay, but the realisation of that idea formed only a stepping-stone in the career of the Society of Jesus. It must not be forgotten that that society was founded on sound trading principles. Its

missions, if not actually self-supporting, were at least expected to contribute towards the expenses of the propaganda, and certain it is that from India, from China, from Japan, and from Paraguay, large sums of money, or valuable consignments of goods, were sent home, in order to forward the objects of the society on the continent of Europe.

It is quite true that when the administration of the Jesuits in Paraguay was challenged, when it was asserted that they had accumulated vast wealth, not only in the ordinary course of commerce, but also from the working of mines, and the acquisition of precious stones and metals, it was proved that from these latter sources no riches had been derived, and naturally, for with the exception of iron and copper, Paraguay has no mineral wealth, but undoubtedly the surplus of the product of trade and commerce, after all expenses had been defrayed, was remitted to headquarters. The soil is so prolific that a minimum of labour is all that is necessary to provide for the maintenance of the inhabitants.

Yerba-maté, or Paraguayan tea, grows wild. It was, and is, a great source of wealth to the country, and during the domination of the Fathers it had a large sale in Italy, and in parts of Southern France, where it was known as "Jesuits' Tea." Cotton can be had for the picking, wood for the cutting; and you have but to scratch the ground, and plant Indian corn, mandioca, tobacco, and sugar-cane, and the crops spring up of themselves. The forests abound in game, and the rivers teem with fish.

All the necessities of life, and all the pleasures that they could appreciate, the Guaranis possessed, with a minimum of labour, before the advent of the Jesuits; and in whose interests was it then that they were confined to the Reductions, were forced to toil, and were isolated from other parts of the country? Surely it was for the benefit of their masters.

Let it be granted that a large portion of the surplus, over and above the wants of the people, was applied to the formation of towns and villages, and to the building and ornamentation of churches and places of worship, yet there must still have remained a very considerable profit.

The Jesuits were skilful tutors and clever traders. They cultivated the Paraguayan tea-shrub, and the cotton that had hitherto grown wild; they improved the tobacco; introduced wooden mills for extracting the juice of the sugar-cane, from which they distilled caña or rum, and numerous liqueurs; they planted vines, from which was produced a wine that was highly appreciated in the River Plate; they utilised the *ibyra* and *caraguata*, textiles that grow wild in great profusion, in the manufacture of ropes and twines; they instructed the men in rude wood-carving, and amongst the women they developed a taste for fabricating hammocks, ponchos, and ñandutay, a beautiful and delicate reproduction in lace of the web of the spider, for which there is still a large demand, and which has been greatly admired in this country.

From all these sources there was a large amount of surplus produce which the Fathers dispatched to their agents and factors in the River Plate, in Brazil, and on the Pacific coast, and, ultimately, the proceeds found their way in hard coin, to the coffers of the society in Europe.

I have mentioned these facts relating to the trade and commerce of the Jesuit Fathers, not with a view to diminish the credit due to them for their conduct during their prolonged occupation of a district of Paraguay, but rather as a proof of the internal and self-contained resources of that country, which was corroborated, and amplified at a later date in its history.

That history may be briefly summarised. The French Revolution towards the end of the 18th century spread far beyond the limits of the European continent. Emissaries from the first Republic found their way to South America and declared their fraternity with the people of La Plata, if they desired to be free, and when, in 1810, Charles IV. and his son Ferdinand abdicated the crown of Spain, the populace of Buenos Ayres quietly deposed their Viceroy, and intrusted the administration to a governing body called a "Junta." One of the earliest acts of that body was to address the people of Paraguay, requesting their adherence to the movement, and their recognition of the new governing power. But Paraguay declined; it declared its desire to maintain amicable relations with Buenos Ayres, but at the same time to retain its independence. The Junta then tried coercive measures; it sent an armed force to Paraguay, but the people, though badly armed and totally undisciplined, rose as one united body to defend the fatherland, drove back the invadors to the Misiones and forced them to capitulate. From that time Paraguay became an independent state: a nation. So it has remained notwithstanding the devastating war of 1865 to 1870,

and so probably it will continue to be, not that it possesses the means of self-protection, but because it holds the position of a buffer State, between two great South American powers, the Brazilian and Argentine Republics.

So soon as Paraguay had discarded by a peaceful and bloodless revolution the domination of Spain, the populace proceeded to establish their own form of administration, and selected that which had already been adopted by France, viz., a government by consuls. Two were chosen, but José Gaspar Francia quickly got rid of his less able colleague, and in 1814 was appointed Dictator for five years, and two years later was declared "Perpetual Dictator of the Republic."

The Jesuit Fathers had raised a barrier between the Misiones and the remainder of Paraguay, but Francia went further, and absolutely cut off the whole country from all communication with the remainder of the world. He simply shut the gates, and did not even leave a box in them for the reception of letters. He declined to receive official communications from neighbouring and foreign Governments, and the despatch of a king of Great Britain, courteously announcing his accession to the throne — as is customary between friendly powers — was returned unopened to Buenos Ayres.

The Dictator or "El Supremo," as he styled himself, did not actually stop trade, but he put it under severe restrictions. Merchants could export and import, but their invoices had to be submitted to his officials; and goods were delivered and received at a riverine port some distance below the capital. Following on the death of Francia, there was a short interregnum—military usurpation—and then the election of two new consuls, one of whom quickly retired, leaving the destinies of Paraguay in the hands of Carlos Antonio Lopez.

With the new administration it had been hoped that Paraguay would again enter into the comity of nations, that restrictions on trade would have been removed, and that communications with the neighbouring States would have been free and untrammelled. But these hopes were disappointed. Again was all intercourse debarred, but on this occasion from the outside, for Don Juan Manuel Rosas, Dictator of Buenos Ayres, closed all the riverine ports on the Panama and Plata against Paraguay. Notwithstanding its complete isolation for nearly forty years, yet it had been rowing all that time in prosperity, wealth, and position to such an extent that in some degree it had become a menace to the neighbouring Republic and to the adjacent Empire of Brazil.

When Carlos Antonio Lopez died in 1862, and was succeeded by his son, Francisco Solano Lopez, the latter found himself provided with a respectable standing army and a large trained reserve; a squadron of gunboats capable of meeting anything that floated on River Plate waters; a series of fortified places on the eastern bank of the Paraguay; an arsenal, a gun foundry, and a large sum of money in the national coffers. In the short period of eight years the vast resources of which Marshal Lopez came into possession had completely disappeared. The soldiers were lying dead upon the field of battle, the national treasury was empty, the flotilla had been captured, the arsenal and forts had been turned into heaps of ruins, the happy and prosperous land had been devastated, the towns and villages destroyed, the rich pasture lands denuded of their cattle, the population reduced from upwards of a million to one quarter of that number and that remnant composed of women and children; not a man was left to till the ground, not an ox to draw the plough, and Lopez himself, the origin of all this misery and ruin, had died sword in hand upon the banks of the Aquidaban.

During his father's lifetime he came to Europe and was well received at several foreign Courts, and especially by the Emperor Napoleon III. At the end of his visit he returned to his own country embued with martial ideas, loaded with the military equipments with which to mount in Asuncion a "Cent Gardes," *à la Francaise*, and accompanied by a lady of Irish birth, who was called Madame Lynch. He could not make her his wife for she was already married, but during his good fortunes she was a Madame Pompadour at the little Court of the capital, and when evil times came round she bravely shared his lot and was with him at his death. She possessed great influence over him, but she was unable to control his ambition which, in 1865, brought on with the allied powers of Brazil and the Argentine and Oriental Republics, a war of five years' duration, to the deplorable consequences of which I have already referred. But the results of that war are somewhat remarkable, and have a bearing on the commercial position of Paraguay, to which I fear that I have not hitherto given sufficient attention.

During its progress many of the indigenous industries died out. The weaving of native

cotton had entirely ceased, and the cultivation of that textile is now on the most reduced scale, for it is found cheaper to import the goods required, than to manufacture them in the country. The class of food of the inhabitants has, in a great measure, been changed. They are no longer satisfied with mandioca and sweet potatoes, but they cultivate largely Indian corn, beans, and rice, and import wheat, flour, and fideos. The result is this, that Paraguay is no longer a self-producing country, to the extent of satisfying all the wants of the population, with a large surplus over; that whereas in 1860 the value of exports was £250,000, and that of imports £130,000, in 1890 the value of exports had been doubled, but that of the imports was nearly equal. A foreign land that did not make purchases would not be worthy of the attention of the mercantile and manufacturing communities of this country; but the above facts tend to prove that Paraguay has now entered into that state of higher civilisation which demands not only supplies of manufactured goods—of clothing, of haberdashery, of hardware, ironmongery, machines, &c.—but also of articles of comfort and luxury; for already its drink bill and fancy food consumption are prominent items of the annual budget.

The demand for foreign goods continues to increase, but want of ready cash prevents their purchase being effected; and although there is abundant produce for export, yet it is not in such a form as would permit of its bearing the cost of transit. Textiles, such as *ramie*, *ibyra*, and many others, which are natural products, have a ready sale in the markets of Europe, but, in order to give a profit, they must be manipulated and prepared before shipment. Dye-stuffs, and many other raw materials, are abundant, but they should be treated with modern appliances, and by skilled workmen before being exported, but machinery, appliances, and instructors are all alike wanting, and there is no capital in the country wherewith to provide them.

Yerba-maté, the Paraguayan or Jesuits' tea, to which I have already referred, timber, unsurpassed for beauty, strength, and durability, oranges in millions, fragrant and juicy, ox-hides, and tobacco and cigars are the principal commodities that are sent down the river in bulk, and have a ready sale in the ports of the Plate, but the ox-hides find their way to Europe, and are especially valuable on account of their weight and condition, and so also does a large portion of the tobacco, and is highly appreciated in this market. But as Paraguayan hides or Paraguayan tobacco, they are only known to a few experts, for they are all classed as produce from Argentina, and unfortunately they have usually paid duty to that State before they reach their final destination. For that is one of the great hardships imposed upon Paraguay by the sister Republics, viz.: a heavy tax on the exports and imports. There is no direct water communication between Europe and Asuncion, and no sea-going vessel can ascend the Parana with safety higher up than Rosario de Santa Fé. The consequence is that all goods have to be transhipped at Buenos Ayres, and then the opportunity is seized to charge dues of all sorts.

The disadvantages under which trade with Paraguay now suffers, could, to some extent, be overcome by establishing a line of river cargo-boats in connection with sea-going vessels from Europe. In some cases, in respect of large cargoes, this has been done, and proved successful in avoiding the payment of unwarranted charges, but it is not practicable in the case of every package dispatched to or from Paraguay. In the distant future there is a glimmer of hope, that means may be found to avert the present system of oppression.

A line of railway 800 miles in length would connect Asuncion with the Port of Santos, on the Atlantic coast. It may well be said that for Paraguay alone such a length of line will never be constructed, but, on the other hand, it would serve to open up the trade of Bolivia and of the provinces of Brazil on the Paraguay, and would traverse a rich country which, according to the superficial surveys already made, presents but few engineering obstacles.

As regards the climate and people, speaking generally of that portion of the country below the tropics, the three summer months, December, January, and February, are undoubtedly very hot, the temperature ranging from 54° to 102° Fahr., but even during that period there are frequent showers of rain, which reduce the temperature, and the nights are always cool. There is never a night in Paraguay when a blanket is not a comfort, The other nine months of the year are like a prolonged spring. Sometimes, in the early morning, the thermometer is as low as 40°, but during the day it rises to 80°, and very seldom exceeds 94° Fahr. There is no regular rainy season, but a great deal of rain falls throughout July, August, and September. The

rainfall is said to amount to 46 inches, distributed over 85 days. The winds from the south bring cool temperate weather, but that from the north-east is hot and damp and enervating. Animals and plants suffer from its effects as much as human beings.

Epidemics are very rare. Small-pox took a strong hold upon the people during the war, but with a compulsory system of vaccination, it is being quickly stamped out. Indigestion, diarrhœa, and dysentery are the chief ailments, but an intermittent fever, called *chuchu*, is often very trying to new-comers, especially when working in the valleys, or engaged in opening up new ground. The country is frequently visited by invalids from Buenos Ayres and Montevideo, suffering from affections of the lung, who regard it as a sanatorium.

In appearance the pure Paraguayan is of medium height and stoutly built, and well put together. His complexion is a warm yellow with a rosy tint; the face is circular, with high-cheek bones and a low forehead; the mouth large, with white and regular teeth; the head covered with blue-black hair, but very little hair on the face. In both sexes the neatness and shapeliness of the hands and feet are remarkable, and in both the look is intelligent and pleasing, and especially soft and kindly in the women. In habits they are clean in person and in dress, very fond of the water, and exceedingly good swimmers. As regards their diet, they are vegetarians and fish-eaters, but care little for meat. They have a peculiar native beer, and also "caña," or rum; but, as a nation, they are very temperate.

As regards their character, the Paraguayans won for themselves during the long war waged against them a reputation for dogged invincible courage, which spread throughout South America, just as the same qualities have won for the British soldier his renown throughout the world; but in peaceful times the Paraguayan is quiet, orderly, domestic, disinclined to revolutionary changes and averse to serious crimes. In some parts of the American continent it is advisable to carry a revolver for self-protection, but in Paraguay such an instrument is quite unnecessary. Their defects are distrust, suspicion, jealousy, partly inherent from their Andalusian ancestors and partly inculcated by the tyrannical governments that established for their own maintenance a system of public and domestic *espionnage*. They are great smokers — to all appearance from their babyhood—and I have seen a mother, for greater convenience in conversing with a gossip, take a large green lighted cigar from her own lips, and place it in those of the baby strung across her shoulders. When the interview terminated she resumed the cigar and went on her way smoking.

For the ornithologist, the zoologist, the entomologist, the sportsman, Paraguay is a favoured land. They may study or destroy, as their inclination leads them, the alligators basking in the mud, the carpinchos feeding on the river banks, or the enormous water serpents, as they swim across the lakes. They may hunt the jaguar or South American tiger, the puma or lion, the tapir, the wild boar, peccaries, red and other deer, antelopes, and ostrich.

In size, in beauty of plumage, and in sweetness of song, the birds of Paraguay are almost unrivalled. The wild turkeys, the curassows, two or three different partridges, a species of grouse, supply good sport for the gun, and food for the table; the dark foliage of the forests sparkle with the pink and white plumage of the great macaws and the gorgeous feathering of innumerable parrots and magpies, and the woods resound with their screeching, and with the unceasing chatter of troops of monkeys, while the horned-mouthed toucans sedately look on, apparently only concerned with the further development of their enormous beaks.

There are some birds with very eccentric notes. The *whistling bird*, with its imitation of a steam-whistle, often confuses the pilot, as he guides his vessel over the swift and silent waters of the Paraguay; and the *bell-bird*, in the thick forest, recalls those days when, in the time of the Jesuit Fathers, the passing bell of a woodland chapel summoned the gentle Guaranis to evening prayer.

In the course of this paper I have referred to the arrival in Paraguay of a number of settlers from the colony of New South Wales. As to their success or failure it does not become me to speak, and I will confine myself to the simple statement that I have been, in my official capacity, in frequent communication with the Agent-General of that colony, and that our intercourse has been most pleasant and amicable. I am in hopes that some reference may be made to that exodus at the conclusion of my paper.

But in the Consulate, with the charge of which I am honoured by the Government of Paraguay, I have, during the last twelve

months, noticed a very considerable movement. A number of young men have already left this country to try their fortunes in that fair land, and many others are preparing to follow them. I have neither advocated their immigration, nor have I attempted to prevent it. I have simply told them the facts—facts that I had previously stated to the Agent-General for New South Wales. That we have no great capitalists, no large employers of labour, no room for clerks, and scarcely room for mechanics; that while a healthy Englishman may do with comfort and convenience a day's work of seven or eight hours, yet, in the construction of railways and other public works, he cannot compete with Italians and other foreigners who will accept a low rate of wages. But, on the other hand, we offer him security of life and property, absolute freedom in his religious and political views, provided he keeps within the limits of moral and social order; a glorious climate, a prolific soil, some temporary assistance from an impoverished Government, and a hearty welcome from the people of Paraguay, who extend an open hand to all comers, but who have an especial regard for the subjects of her Britannic Majesty.

DISCUSSION.

The CHAIRMAN said this paper did not offer much ground for discussion, but there must be a great deal more to be said about this comparatively unknown country, and any further information with regard to it, or to the colony from Australia recently founded there, would be very welcome.

Mr. A. ROGERS said he had been asked by Mr. Casey, the general organiser of the new colony, to afford any information he could, and he should be happy to do so to anyone who would apply to him. He had prepared a short history of the settlement, which could be had on application. He should be going out there in about a month, and about twelve others with him. Mr. Casey would be in England in about a month, and, he believed, he intended to make a tour through England, and perhaps Scotland also, for the purpose of obtaining further support. Last month thirty went from Australia, and more had gone this month; in fact, men were now going direct from Sydney and Adelaide every month.

Mr. BAILLIE said he should be glad to know if the colony was really getting on, or whether it was coming to grief in any way.

Mr. ROGERS said the latest reports were very satisfactory indeed. The men were very contented; they had built themselves houses, and he could give the number of acres of land broken up, the number of cattle and poultry they possessed, the gardens they had planted, and so on. Vines and tobacco were being grown, and altogether, he believed, things were very satisfactory. Last May there was a decided split in the settlement, and some eighty of the original settlers left, but that was mainly owing to the action of the original leader, who, he was convinced, had become the victim of religious mania. He endeavoured to force his views on the settlers, to which they objected, and the consequence was that he left with some of his followers, and formed a separate colony under a directly religious rule. The remainder, to the number of about 300, were very well satisfied with their present position.

Mr. FRANK B. PASSMORE said he was in Paraguay in September and October last, when he met with some members of the Australian settlement, who were returning to Australia, and who did not give very flourishing accounts of the settlement, but he was glad to hear that it was now doing well, and there was no reason why it should not if carried on in an intelligent manner. He was also glad to hear that there was a stream of emigrants setting in, for the one thing Paraguay wanted was more labour. It was a very fertile country, but the people themselves were exceedingly idle, as was shown by the fact that the women did nearly all the work. He found that in places where for the smallest amount of labour almost anything could be obtained, he could often get nothing to eat but mandioca, and sometimes very little of that. He had brought with him a sample of the *yerba* (sometimes called Jesuits' tea); it was a tree which very much resembled an orange tree, but the leaves were much like the laurel. The branches were cut off, dried under a thatched roof by a bright wood fire made of sweet smelling wood, and then either beaten with sticks on a prepared floor, or cut up in a kind of mortar mill by revolving knives, until they assumed the form shown. Many people did not like the tea, but he must say he did; he had frequently taken it at three or four in the morning, and could then go till ten or eleven without feeling the want of food. No means had yet been found for cultivating the plant from seed; it grew spontaneously in the woods, especially in the district shown as hilly on the map exhibited on the wall, between Rosario and Concepcion, and, in some cases, he believed young trees had been transplanted. He had no doubt there was plenty of game in the country, as he had seen their tracks, though he saw very little actual game in his travels through the country. In the rivers there was what was called seal, but it was really an otter, called lobo. The alligators were not so numerous as in Central America, and of a different type; he was told they were not dangerous to human life, but could not speak positively as to that. He had been in the "misiones," and he must say that

the buildings there were much superior to anything which could be seen in other parts of the country—he did not refer to the towns, of course. He could not help thinking that the tuition these people received from the Jesuits was calculated to make them useful members of society. There seemed to be a great difference between the character of the people now and that which existed before the war. Paraguay only wanted honest government, labour, and enterprise to become a flourishing country.

The CHAIRMAN said he had recently read in an Australian paper a very bad report of the settlement in Paraguay, stating that the colonists were in a state of semi-starvation, and that all who could get away were returning to Australia as fast as they could. He was very glad to hear this contradicted. No doubt this country, like many others, if it had labour and enterprise devoted to it, would very soon yield results which were not at present discernible. With regard to the sample of *maté* tea which had been produced, he was afraid the ladies of this country would not take kindly to it in their drawing-rooms, but there was no doubt that it had great sustaining power; in fact, that was its chief characteristic. He had known gentlemen speak of having taken long rides with no other refreshment than this peculiar stuff, which had a sustaining power which neither tea, coffee, nor even chocolate could claim. Still, he thought it would be many years before it would compete with Indian tea in the English market. The absence of labour and enterprise, which Mr. Passmore mentioned, was, he thought, accounted for by the five years' war under Lopez, at the end of which time there seemed to be very few besides women and children left in the country, the male population having been to a considerable extent wiped out; and he gathered that those were the people of whom Mr. Baillie spoke so highly. There was no doubt that if steam communication were opened up to Paraguay, the growing demands for beef and mutton in Europe would soon lead to a development of trade with that country. He concluded by proposing a hearty vote of thanks to Mr. Baillie for his interesting paper.

The vote of thanks having been carried unanimously,

MR. BAILLIE, in reply, said he was glad to hear that so many settlers were going out from England, and he wished them every success.

TWELFTH ORDINARY MEETING.

Wednesday, Feb. 20, 1895; PROF. W. C. ROBERTS-AUSTEN, C.B., F.R.S., Chemist to the Royal Mint, and Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Dawson, James Henry, The Grange, Tilford, Farnham, Surrey.
Peers, George Robinson, 34, Memorial-road, Walkden, near Bolton.
Reynolds, Alleyne, Bolsover Hill, Sheffield.

The following candidates were ballotted for and duly elected members of the Society.

Bates, Matthew, Bromley, Kent.
Cowling, John Combe, Surveyor's-office, Urban District Council-offices, Cockington, Devon.
Holden, Timothy, 36, York-street, Broughton, Manchester.
Hoskins, Admiral Sir Anthony Hiley, G.C.B., 17, Montagu-square, W.
McCreery, James, 257, Albert-bridge-road, Belfast.
Maton, Leonard James, 21, Cannon-street, E.C.
Steward, John J., 457, Strand, W.C.
Ward, Colonel James, C.B., Junior Carlton Club, Pall-mall, S.W.
Wells, Sidney Herbert, Polytechnic Institute, Battersea, S.W.

The paper read was—

FURNACES FOR ROASTING GOLD-BEARING ORES.

By C. G. WARNFORD LOCK,
M.Inst. M. and M.

Introductory.—The title of this paper has been chosen with deliberation, and is meant to be explicit. It implies that the subject for discussion is the apparatus in which the operation of roasting is conducted, rather than the numerous chemical problems involved in the process, and which vary somewhat with the nature of the mineral under treatment. The term "gold-bearing ores" is chosen in preference to any other, as being correct and comprehensive: such expressions as pyrites, sulphurets, concentrates, are discriminatory, and would exclude from consideration large quantities of auriferous rock, which are neither the one nor the other.

Objects of Roasting.—In this connection roasting may be said to have a dual object—physical and chemical. The physical result aimed at is an increase in the porosity of the rock, and in some few instances, notably where cyanide treatment is to follow, this may be the chief desideratum. The chemical change sought to be brought about is the elimination of sulphur and arsenic, and the conversion of sulphides and sulphates, arsenides and arseniates, into oxides. The double object is accomplished by heat and air in one operation in properly constructed furnaces, and is variously known as calcining, "sweet" roasting (since all acids are removed), oxi-

dising roasting (because other salts become oxides), or roasting "dead" (alluding to the absence of sparks and the blackened appearance of the mineral when the roasting has been thorough). The physical disruption of the ore is, of course, further aided by the chemical changes taking place in its constituents, and thereby the isolation of the gold particles is facilitated. In the very great majority of instances—perhaps in all, except where bismuth or tellurium occurs in the ore—the gold exists in what is known as the "free" state, that is to say, it is not in chemical combination, but only in extremely intimate mechanical association with the other constituents, sandwiched, as it were, between the grains of pyrites, or what not. This is clearly shown by the fact that when such ores are ground sufficiently fine, the gold can be recovered from them by the medium of mercury. But the presence of sulphur, arsenic, &c., has a deterrent effect on the action of mercury, and their partially oxidised products, such as sulphates and arseniates, are even more detrimental, not only to amalgamation, but also to chlorination and other methods of gold recovery. Hence the complete transformation into innocuous oxides is generally an essential condition of successful roasting.

Principles of Roasting.—In discussing the principles which should guide the operator in conducting a roast, it is impossible altogether to avoid entering into chemical questions, as they underlie the operation. In the early days of the gold industry of this century these chemical problems were quite ignored, and many disastrous failures were incurred in consequence.

The principal constituent of almost all ores which require roasting is iron pyrites, either the magnetic form, known as pyrrhotite or monosulphide (FeS), or the common variety, called pyrite, which is a bisulphide (FeS_2). If these minerals are subjected to heat without air, the sulphur is volatilised. If air has free access to them during heating, the sulphur burns, passing through the stage of sulphurous anhydride (SO_2), and rapidly becoming sulphuric anhydride (SO_3). This sulphuric anhydride attacks the iron, and forms ferrous sulphate, and unless the heat be sufficiently great to decompose this sulphate of iron, much of the original sulphur will remain in that form. If the heat be duly raised and prolonged, the final result will be ferric oxide (Fe_2O_3); but if the heat be unduly raised or prolonged some of this will be changed to magnetic oxide (Fe_3O_4), which is an objectionable feature, if chlorination is to follow; or, again, excess of heat, in presence of a lack of air, may even result in one atom of the sulphur being removed, and a fluid slag of monosulphide of iron being formed. Either, or all of these conditions, may be encountered simultaneously in different parts of the same furnace.

Next in importance, if it be not, in some cases, of paramount importance, is arsenopyrite, or mispickel, the arsenical sulphide of iron (FeAsS). The expulsion of arsenic would seem to be a much more complicated matter than the elimination of sulphur, because, while it is volatile only in the condition of arsenious acid, it will repeatedly undergo modifications in the furnace, according as the ever-varying atmosphere in contact with it is more sulphurous or more oxygenous. In presence of an excess of oxygen there is a tendency to form fixed arseniates of the iron and other metals present, and these arseniates are decomposed only at very high temperatures; therefore rapid or intensified oxidation of arsenic is to be avoided.

Much the same remarks apply to antimonial sulphides (stibnite, &c.), which, as antimoniates, are even more troublesome than arseniates.

Lead sulphide (galena) demands equal caution in controlling the rate of oxidation, by reason of its tendency to produce fusible compounds.

Zinc sulphide (blende) requires a high temperature and an abundance of air.

Enough has been said to indicate that the efficient roasting of mixed sulphides is not a simple matter. On an industrial scale, perfection cannot be attained, and the main principle kept in view is to let the heating and oxidation be gradual at first, progressing regularly, and terminating at the highest point, which should not be prolonged beyond actual needs. This gives the best general result on the average ores dealt with, but special cases require special modifications. Thus, when antimony is in large proportion, steam is introduced as a source of hydrogen, to hasten the operation; when much copper is present, salt is added, if chlorination is to follow; and so on.

Furnaces.

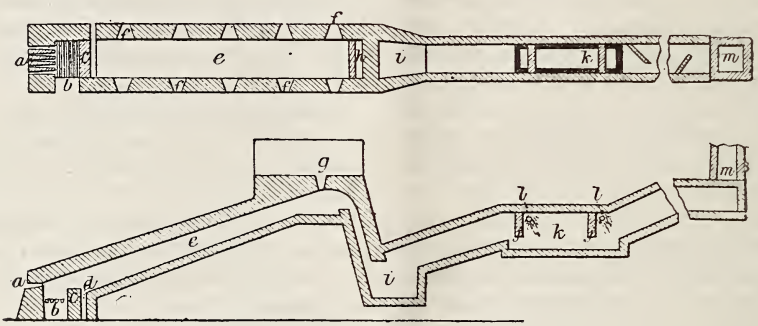
The object of all the furnaces under discussion is to promote the access of heat and oxygen to the ore, hence their differences of construction depend in the main upon the

means which are adopted to favour these ends. They may be first divided into two main groups, according as the ore is worked over, so as to expose new surfaces to the air and heat, (*a*) by manual labour, and (*b*) by mechanical contrivances.

(*a*.) MANUAL FURNACES are represented by the various forms of reverberatory calciner, which have stood the test of time, and are still considered by many to be the most efficient furnace for securing a sweet roast.

The essential features of the common reverberatory are a long, broad hearth, having a gentle inclination (say, one inch per foot) from the fire-end up towards the feed-end, and covered by a low-vaulted roof. The height of the hearth above the ground-line should be about three and a half feet, and its width about twelve to fifteen feet, for most convenient operation. The length varies greatly—sixty to eighty feet is desirable from the standpoints of fuel economy and efficiency—but these considerations are often overlooked or made subservient to economy in cost of construction, the length being reduced to forty or even thirty feet. Sometimes the hearth is divided laterally into three or four sections by drops of a few inches each, but more generally the bed is of one uniform grade without divisions, though still called "3-hearth" or "4-hearth," which terms, however, simply indicate that the length is three or four times the width. The hearth should be built of brick set on edge, as close as possible, in fireclay. For the lowest section of the furnace, as well as for the fireplace and bridge, best firebrick will prove cheapest in the end. The upper sections of both hearth and vault may be of sound

FIG. 1.



VICTORIAN REVERBERATORY.

a, air pipes above the fire; *b*, fireplace; *c*, firebridge; *d*, discharge slot for roasted ore; *e*, hearth; *f*, working doors; *g*, charging hopper; *h*, flue leading to condenser pocket *i*; *j*, stops for checking flow of gases; *k*, leaden cistern in which gases condense, aided by sprays *l*; *m*, chimney.

ordinary brick. The space beneath the hearth should be made solid with rubble, to conserve the heat. The thickness of the vaulted roof is generally one brick (nine inches), and the distance between hearth and vault commences at about two feet at the fire-end (less in a small furnace) and diminishes somewhat towards the other. It is essential that the fuel used be of a long-flamed character. The pulverised ore is fed on to the uppermost section of the hearth, and spread so as to lie two or three inches deep (about fifteen pound per square foot), in a succession of ridges and furrows. Spreading is performed by heavy iron "paddles" or rabbling tools, which are admitted by small "working doors," in cast-iron frames six to nine inches high, and tapering from twelve inches long on the outside to eighteen inches on the inside. A series of these doors on each side of the hearth for its whole length, at intervals of about six feet, permit the charge to be periodically rabbled and moved on towards the fire. The working doors should alternate on the opposite sides. Long flues for condensation of the sulphurous and other vapours generated are necessary, and a chimney to give draught to the fire. The products of combustion from the fire, together with air entering at the fireplace and at the working doors, pass over the exposed surfaces of ore and produce the desired oxidation. The oxidised ore escapes through a slot in the hearth just behind the firebridge.

A form of reverberatory favoured in Victoria is shown in Fig. 1. It is highly efficient, pyrites containing about 7 per cent. arsenic

and $6\frac{1}{2}$ per cent. sulphur being roasted sweet in 12 to 18 hours. But the cost is very high. Treating 4 to $4\frac{1}{2}$ tons per 24 hours, the cost is about 13s. a ton for labour and 9s. for fuel; total 22s. Cosmo Newbery puts the average cost of roasting by reverberatory throughout Victoria at 18s. a ton, and figures which I collected in California last year show much the same cost there. This, of course, is simply throwing money away. Some economy of operative cost has been aimed at by building the furnaces with superposed hearths, but the increased cost of construction and expense for repairs seem to have more than counterbalanced the saving.

The effectiveness, then, of the hand-worked reverberatory is gained at the sacrifice of fuel and labour. The oxygen carried in by the air entering at the fireplace, even when supplemented by air pipes, as shown, is mostly consumed in supporting the combustion of the fire, leaving but little for effecting oxidation of the ore. The demands for the latter object are supplied by the air admitted at the working doors, which, however, is cold, and therefore lowers the temperature of the furnace and causes waste of fuel. If the work is hastened, not only is additional fuel consumed, but considerable mechanical loss of ore may be caused by the excessive draught. If the work is prolonged, the cost of labour is augmented. Therefore it does not seem that any great improvement can be introduced in the reverberatory system, unless it be in the direction of utilising the waste heat for warming the fresh air supplies, which, however, does not promise to be very feasible.

(*b*.) Mechanical Furnaces comprise four distinct classes:—(1) shaft furnaces; (2) rotating cylinders; (3) mechanical rabblers; and (4) rotating beds.

1. *Shaft furnaces* have come into very limited use in calcining auriferous ores, despite the acknowledged advantages of dropping the ore in an ascending stream of hot air, which is sometimes sought to be attained, though very imperfectly, by making deep steps between the several hearths of the reverberatory.

The well-known Stetefeldt furnace is an example of the crudest and worst form of shaft furnace, the ore falling without let or hindrance straight from the top to the bottom of a 30 or 40 feet shaft, which obviously does not permit of a sufficiently prolonged contact between ore and heated air to effect more than a partial roasting. It is quite unsuited to the purpose under review.

To suppose that what occupies 12 to 18 hours in a reverberatory can be accomplished instantaneously, as it were, in a shaft furnace, is hardly reasonable. Nevertheless, experiments prove that a period of one minute suffices for the sweet roasting of a single pyrites grain under the most favourable conditions of temperature and access of hot fresh air. The problem is to apply those conditions on an industrial scale to enormous numbers of grains simultaneously.

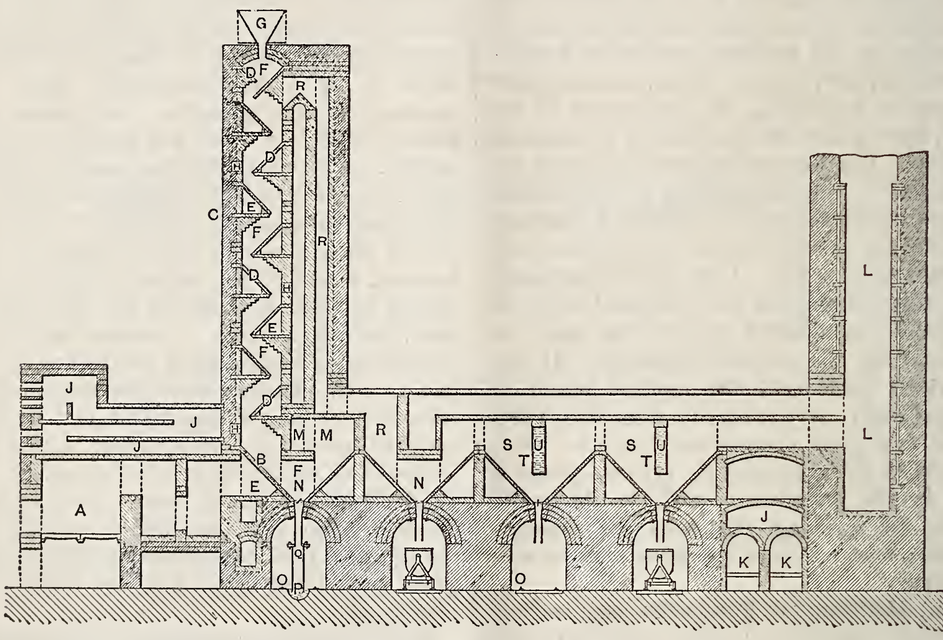
Another feature, which is of great importance economically, is the heat generated by the combustion of the ore. In theory, while the combustion of coal produces a temperature of about 5000° Fahr., the combustion of iron pyrites should produce at least 1800° Fahr., which is a higher temperature than is necessary for the operation, and allows a liberal margin for waste and imperfect combustion. This is verified in practice every day by the pile-roasting of cupriferous pyrites, where fuel is used only to ignite the mass; and by the pyrites kilns of the sulphuric acid industry, where the ore, broken to egg-size, is burned in thick beds without any fuel whatever: the oxygen of the air admitted sufficing in both instances to support combustion once commenced. The essential differences in the conditions of the two cases of the acid works and the gold mill are—(*a*) that complete oxidation is not attained in the former, but is generally essential in the latter; (*b*) that the ore is in lumps in the one, and in powder in the other; (*c*) that the sulphurous and other gases are utilised in the first, and wasted in the second.

But considerable quantities of dust pyrites are made in breaking and hauling the ore at the acid works, and this fact led, many years ago, to the invention of a furnace for burning them, known as the Gerstenhöfer, which carries out to the full the principle of making the pyrites support its own combustion. The dust ore is caused to fall down a vertical shaft, its descent being delayed by a number of triangular crossbars; these break up the stream of falling ore, and help to cause an exposure of every particle to the rising current of air admitted at the base of the shaft. When the furnace has once been heated to dull redness no further fuel is needed to maintain it in operation on a richly sulphurous ore, such as ordinary pyrites. The sulphuric anhydride generated in the process is utilised for making

sulphuric acid; in fact, that is the main object of the furnace, though it has also found an important sphere of usefulness in dealing with cinnabar "fines." With the provision of more air inlets, fitted with dampers, and the exercise of care in controlling the temperature and feed, I am convinced that this long-known and well-tried furnace would meet the wants of many goldfields, where highly-sulphuretted concentrates are produced; and if the waste heat were utilised to warm the fresh air supplies, and the latter were regulated by a fan or other contrivance under complete control, no better, more simple, enduring, inexpensive, economical, and efficient furnace could be desired. If care be taken that the pyrites is reduced to 100 mesh, and the shaft be built 40 feet high, an absolute dead roast can almost be guaranteed, while the wear and tear, labour, and fuel consumption are only nominal.

Several modifications of this system have been introduced or proposed. Thus Fauvel's furnace has a series of sloping shelves alternating from opposite sides, with provision for heating the fresh air, while the products of combustion from the fireplace are prevented from coming into contact with the ore. It is

Fig. 2.



Fauvel's Furnace.

A, fireplace, in duplicate; B, lowest shelf of oxidising tower C; D, series of shelves; E, heating flues for shelves , passage for falling ore; G, automatic feeder; J, air-heating chambers.

shown in Fig. 2*. So far as I know, this furnace has not yet been put into actual use at any gold mine, therefore working results cannot be quoted, but it looks highly promising.

A furnace which Cosmo Newbery was experimenting on in Victoria some years ago, and which he thought promised good results, was made with an inclined floor of "tiles" (presumably fireclay slabs), arranged so as to allow air to enter between them. They are about six inches wide, and are placed at an angle of 33°, so that the ore flows down in a constant stream. In the roof and under the floor are air-pipes, by which air, heated by the combustion of the pyrites, may be delivered over each tile. A somewhat similar furnace was erected at Charters Towers, Queensland, but admitting all the air supply at one point, which is a serious error.

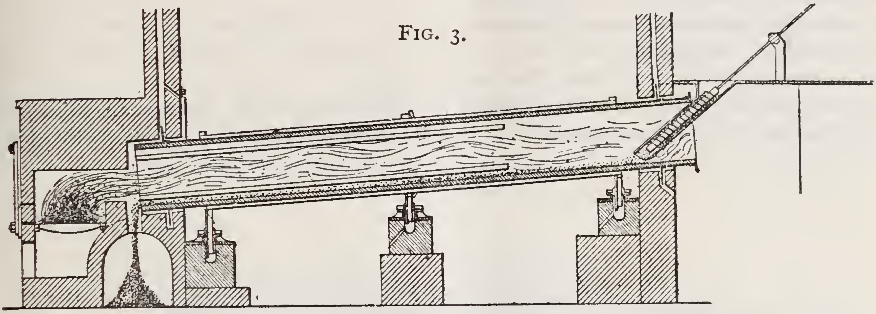
2. *Rotating Cylinders* are known by a variety of names, especially in the United States. They may be divided into two groups—those with open ends, which are fed and discharged continuously; and those with closed

* For more detailed description, see "The Miners' Pocket Book," p. 369.

ends, which are fed and discharged intermittently.

The original form of the continuously operating cylinder is the Oxland and Hockin calciner, invented many years ago for treating arsenical ores in Cornwall; thence it was introduced into America, and is there called the "White," or "Howell-White roaster." It is shown in Fig. 3, and consists essentially of a wrought-iron cylinder, 20-30 feet long, and 3-4 feet inside diameter (often an old boiler shell), lined with firebrick, and mounted in an inclined position, resting on wheels, which cause it to revolve slowly. The flame and gases from the fire pass through the cylinder in contact with the descending ore, which is fed in at the upper end by a screw conveyor. To increase the agitation and exposure of the ore, four straight, parallel ribs of brickwork are carried down the cylinder for the greater portion of its length, and these alternately pick up the ore and drop it through the flame. Working on arsenical pyrites in Cornwall, such a furnace roasts 20-25 tons per 24 hours, consuming only 10-20 lb. of coal per ton, and costing for labour but 1s. a-ton, at Cornish rates of wages, but requiring 2-3 h.p. motive-power. With proper control of feed, fire, and

FIG. 3.



OXLAND AND HOCKIN CALCINER.

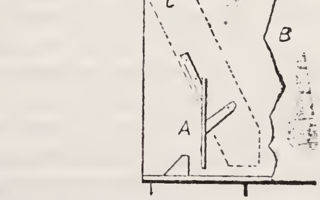
draught, it does excellent work. A similar furnace, 60 feet long and 7 feet diameter, is used in Wales for calcining "white metal" down to one per cent. sulphur, at a cost of less than 1s. 7d. per ton, including interest and repairs.

Enormous quantities of auriferous mispickel have been calcined in this class of furnace at Marmora, Canada, preparatory to chlorination, therefore needing a sweet roast. Some modifications, however, were here introduced, which add materially to the efficiency of the furnace. Thus, the brick ribs are made in spiral form, and only occupy the upper 4 feet or so of the cylinder, being replaced below by tile diaphragms 4 inches wide, meeting in the centre, and dividing the cylinder lengthwise into four separate compartments. About halfway down, one inch gaps are left in the diaphragms, to enable the ore to stream through, and fall across the air currents, which are supplied by a fan. These improvements are due to Rothwell, who claims, that with two furnaces thus equipped, one 30 feet by 5½ feet, delivering into a second 60 feet by 6½ feet, 48 tons mispickel were roasted per 24 hours, with two men per 12-hour shift, and only half the previous consumption of coal.

Working on ore carrying about one per cent. each of sulphur and arsenic, crushed to 8 mesh, with labour at 10s. a day, and fuel at 14s. a cord (or 2s. 6d. a ton of ore), sweet roasting is done for 3—4s. a ton with this furnace in the United States.

Other modifications which have been proposed in this widely-used furnace, with the object of increasing its capacity or efficiency, relate particularly to the feed. Thus, Pardee constructs a feed pipe with "diaphragm," as shown in Fig. 4, in which a boiler-plate

FIG. 4.



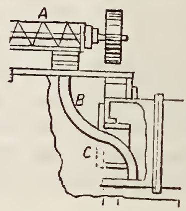
PARDEE "DIAPHRAGM."
A, flange; B, cylinder; C, feed pipe.

flange, in shape a segment of a circle, is so fastened to the inclined feed pipe as to come within half an inch of the circumference of the rotating cylinder; by this means, the cold ore entering by the feed pipe is not exposed to the escaping current of heated vapours, which are deflected by the flange towards the top of the outlet. The proportion of flue dust made is thereby greatly reduced, causing an economy of fuel and labour, and an increase in output. This was successfully worked for some years in Montana.

Rumsey's "diaphragm," also adopted in Montana, is shown in Fig. 5. The upper end of the cylinder is made with a considerable flange projecting inwards, so as to form an annular chamber; the pipe delivers the feed into this annular space, and here the ore remains for some time before it encounters the heat and draught of the furnace proper.

The objects sought to be attained are the same as in Pardee's invention. Neither seems to have extended much beyond the place of its introduction, though beneficial results are claimed for both.

FIG. 5.

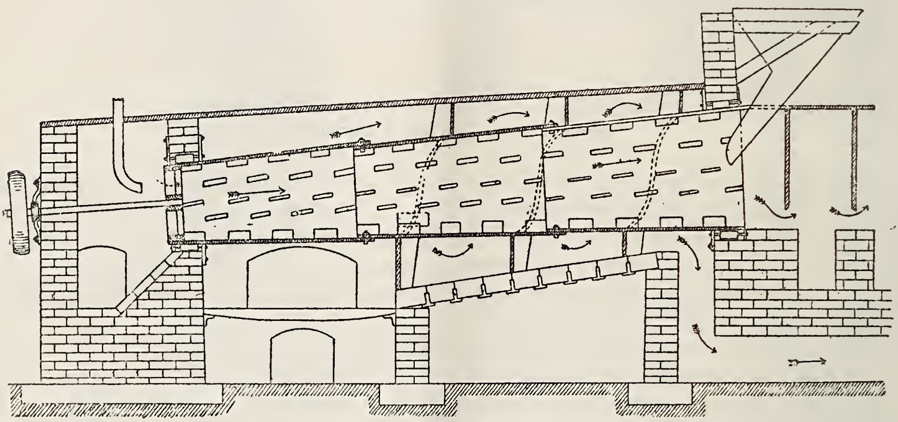


RUMSEY'S "DIAPHRAGM."

A, screw conveyor; B, feed pipe; C, rotating cylinder.

The Molesworth furnace is a suggestion from South Australia, and is shown in Fig. 6.

FIG. 6.



MOLESWORTH CALCINER.

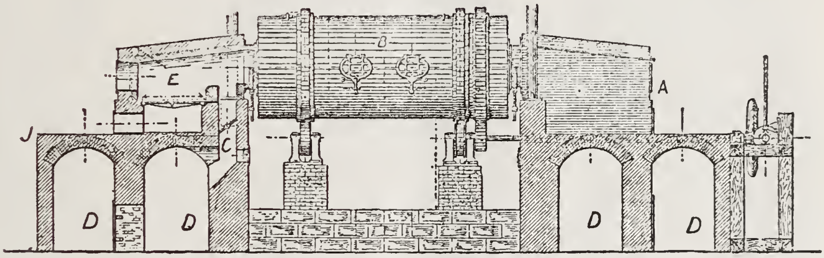
It is made of iron, 15 feet long, of conical shape, set on an incline with the smaller end downwards, and revolving on friction pulleys. The products of combustion from the fire-box under the smaller end circulate through flues arranged round the furnace, and do not enter the roasting cylinder proper, thus avoiding waste of oxygen. The ore is fed in at the upper end, and during rotation the particles are raised on shelves and dropped through the heated atmosphere. The energy of the oxidation is stimulated by the use of an oxygen-carrier in the shape of gaseous nitric oxide, generated by the action of sulphuric acid on nitrate of soda (a feature borrowed from the sulphuric acid industry); thus nascent oxygen encounters the ore at the moment when its heat is greatest, and when most of the sulphur and arsenic have been expelled, with the object of securing very perfect oxidation. But so long as air can be had for nothing, it is hardly likely that this innovation is destined to be adopted. With so much iron exposed to the action of the sulphurous gases, the wear and tear of this furnace is likely to prove excessive.

The type of the intermittent revolving calciner is the so-called Brückner, which, I am assured by Mr. Mactear, is simply the black ash furnace of the alkali maker, invented, in 1848, by Elliott and Russell, of Newcastle, improved by J. C. Stephenson, of the Jarrow Chemical Company, and further by Mr. Mactear himself, who converted the cylinder into a barrel, and quadrupled its efficiency. It would seem that when Brückner introduced the fur-

nace into Colorado, in 1887, he added a series of internal iron pipes, with the object of augmenting the disturbance of the ore during rotation. Of course these interior fittings, called a "diaphragm," were rapidly destroyed, and soon came to be discarded, so that the "improved" Brückner of to-day is a reversion to Mactear's barrel. The rotation is effected by friction wheels in preference to toothed gearing. Towards the ends the cylinder is contracted by adding extra layers of brick lining, till the internal diameter is reduced from about 7 feet to 2 feet. In modern practice the length is preferably about 18 feet, and a charge about 7 tons. The feed and discharge openings are opposite each other in the sides of the cylinder, instead of at the ends. One end admits the products of combustion from the fireplace, while the other discharges into flues leading to condensing chambers, and thence to the chimney. Obviously the ore can be retained in this furnace for any desired length of time, and that is the sole advantage it possesses over the Oxland. On the other hand, the charge is always unequally roasted, so that to ensure all being sufficiently calcined much must be over-roasted, incurring great waste of fuel. Moreover, the air-supply is insufficient; and the gradual increase of temperature which is so desirable in an oxidising roast can only be attained by alternately checking and urging the fire, added to which, the mechanical losses of dust are excessive. Quite as much motive power is required for this furnace as for an Oxland with three or four times the capacity. The cost of calcination in the case of an ore carrying about 7 per cent. each of sulphur and arsenic, crushed to 8 mesh, is not less than 6s. a ton, with labour at 10s. a day and wood fuel at 14s. a cord.

To mitigate some of the evils of the Brückner, Hofmann has introduced the fur-

Fig. 7.



Hofmann Double-fired Barrel.

A, E, fireplaces, one at each end; B, rotating barrel; C, flues; D, dust chambers.

nace shown in Fig. 7, which has duplicate fireplaces—one at each end—so arranged that the firing can be alternated in either direction. Supposing the fire to be lit first in the right-hand fireplace, the draught passes through the barrel, carrying the fumes down the flue into the dust-chambers beneath, and thence to the chimney. In due course, firing is done from the other end, the dampers being altered to create a draught in the opposite direction. An arrangement of dampers also permits the introduction of a supplemental current of cold air directly into the barrel, so that it will occupy a stratum between the ore and hot tainted vapours lying above it. This latter feature is claimed to greatly assist rapid oxidation—and no doubt it does assist—but hot fresh air would be better; moreover, the same thing exactly has been done at one of the chlorination mills in the Black Hills (long since shut down), by placing a connecting cylinder between the firebox and the barrel, and cutting a hole in it, with a sliding door, so that this part of the inventio [illegible] original. As to the use of alternate fires, the extra labour and waste of fuel probably entirely nullify the advantages of a somewhat more complete roast, for it is still imperfect.

3. *Mechanical rabblers* embrace a number of furnaces with stationary beds and automatic machinery for stirring the ore and exposing continually fresh surfaces.

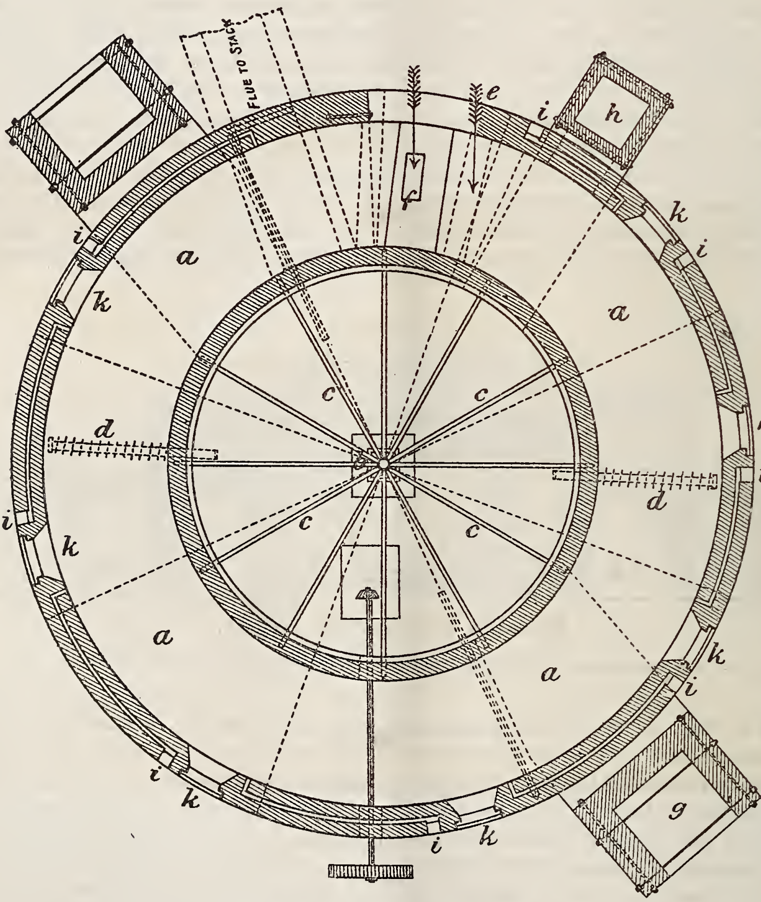
Probably the oldest form is O'Hara's, consisting of two hearths with very low roofs, one placed above the other, and provided with endless chains carrying a series of "ploughs," arranged so that each set turns the ore in an opposite direction, from side to centre and *vice versâ*. The ore is made thus to gradually approach, first the orifice leading from the

upper to the lower hearth, and then the fire-end of the latter, where it falls into a pit. In efficiency, capacity, cost of operating, and wear and tear, this furnace is quite out of date.

In the Spence furnace*, the travelling ploughs are replaced by rakes having a longitudinal reciprocating motion, actuated by machinery. In other respects it resembles the O'Hara. Except that the number of superposed hearths may be more than two, the objections on the score of efficiency, capacity, cost of operating, and wear and tear are the same. Neither of these furnaces, in fact, is fitted to perform sweet-roasting, and in several instances where they have been built with that object they have been pulled down after trial.

The Brown-O'Hara, which soon developed

FIG. 8.



PEARCE "TURRET" FURNACE.

a, reverberatory hearth; *b*, central column; *c*, radiating arms; *d*, rabble blades; *e*, ore feed; *f*, ore pit; *g*, fireplaces; *h*, dust flue; *i*, *k*, air inlets.

into the Brown-Allen and thence into the Brown "Horseshoe," dispenses with the superposed hearth and adopts a single hearth built in annular form, with a section equal to about one-third of the total circumference removed, whence the term "horseshoe" has been derived. This form has some distinct advantages. The shape gives the greatest capacity in the smallest space and permits of centrally-driven rotating rabbling gear, while the parts exposed to the fire and gases are beyond these injurious influences during one-third of each rotation, thus greatly lengthening their lives.

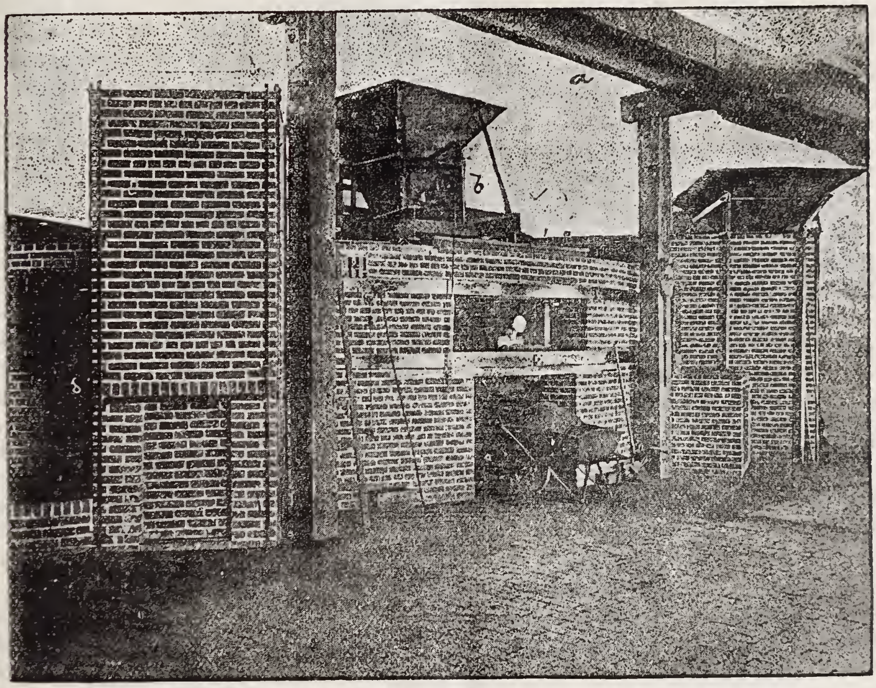
The Pearce "turret" furnace, shown in Figs. 8 and 9, is the newest form of mechanical rabbler, and claims attention as being the

* Described in great detail in Peters's "Copper."

invention of a prominent metallurgist managing one of the largest smelting works in the United States, where it has been adopted to the exclusion of all others.

It consists of an ordinary reverberatory hearth built in circular form, the centre of the circle being occupied by a central column supporting radiating arms which carry rabble blades. The ore is fed in mechanically, and after traversing the whole circle of the hearth at any desired speed, falls by gravity into a pit. Air is forced through the pipe arms and discharged against the rabble-blades, performing the double duty of cooling the ironwork and furnishing heated air to the roast. Two or more stepgrate fireplaces, automatically fed, supply heat. The space beneath the hearth is utilised as a dust flue. The cost of a 36 feet Pearce furnace is £800 for ironwork and erection, based on Colorado prices, with £300 for royalty. Repairs are confined to renewal of rabble-blades every three or four weeks. One man per shift can feed fuel and ore, remove roasted ore, and attend to machinery of one furnace, if assisted by the mechanical arrangements shown in Fig. 9. The air supply can be controlled not only through the perforated arms, but also by additional inlets. The degree of roasting can be adjusted to any desired point, from a dead roast to any per-centage of sulphur, and to fusion or sintering. For chloridising, salt can be added at any point; and the furnace can be used for drying or for cooling. The dust is much reduced. Its capacity varies from 10 to 20 tons per 24 hours. Very inferior fuel can be used if forced draught is applied. No other furnace is so well designed for keeping the roasting in perfect control, and in that direction rather than in economy lies its superiority.

Fig. 9.



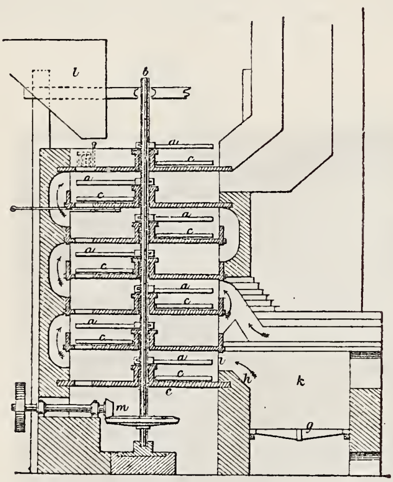
Pearce "Turret" Furnace.

Showing overhead tramway *a* by which ore and fuel are brought, ore feed hopper *b*, and discharge opening whence the ore is drawn and shovelled into wheelbarrows.

A modification of the automatic rabbling furnace, which introduces the advantages of the drop action, is Denny's, shown in Fig. 10. A self-acting grate at the bottom of the hopper admits a charge at intervals. On the top shelf drying only is effected. The next shelf retains a 4 cwt. charge for twenty minutes or so,

during which time the ore is continually stirred by the loose rake hanging from the revolving arm. A slide operated by a boy opens a slot in each iron shelf, which allows the charge to pass downward at intervals till it finally reaches the lowest shelf. Besides the air entering by way of the fireplace, additional supplies are furnished at about one-third of the height of the furnace, after being heated

FIG. 10.



DENNY'S DROP FURNACE.

a, arm revolving with shaft *b*, and carrying loose rake *c*; *e*, base plate; *g*, firebars; *h*, firebridge; *k*, fireplace; *l*, hopper; *m*, bevel wheels.

in a capacious air-space immediately over the fireplace. While possessing some good features, notably in the drop action and in lessening mechanical loss of dust by the numerous impediments to the draught, the destruction of the internal ironwork must be exceedingly rapid, making the cost of maintenance heavy, and adding to the risks of stoppage by disablement.

4. *Rotating Beds*, or furnaces in which the rabbling mechanism is stationary while the roasting hearth revolves, are also typified by an old Cornish calciner, known as the Brunton. This is essentially a circular reverberatory, with a firebrick hearth laid on a slightly convex iron table, which is made to revolve slowly. The ore, fed in at the centre of the low domed roof, is gradually worked towards the outer edge of the hearth by numerous iron "flukes" or blades projecting downwards from the roof. In treating arsenical pyrites in Cornwall, this furnace has an average capacity of 4 to 5 tons per 24 hours, employing one man per 12-hour shift, and consuming 1½ to 2 cwt. coal per ton calcined, in addition to that consumed in generating power to give motion to the hearth. Therefore it cannot be regarded as economical.

Nevertheless, a few modern furnaces have been founded on this type. Serjeant and Flude's, shown in Fig. 11, was introduced some years since in Victoria, and has the laudable object of utilising the sulphurous gases for making sulphuric acid and recovering the arsenic as arsenious acid (white arsenic). The feed hopper delivers automatically, and can be adjusted to suit the demands of the ore and the speed of the furnace. No fire passes over the ore during roasting, but an abundant supply of heated air is furnished through holes in the crown of the furnace. In this respect, the furnace is a great step in advance, and takes priority (with Fauvel's) over all others. The duration of the roasting can be nicely adjusted to the needs of the ore, and every product is utilised. This last feature, if not yet a pressing matter on most gold-fields, is bound to assume greater importance, both on economic and on sanitary grounds, in the near future, and no system can be regarded as perfect which entails waste. The mingling of the products of fuel combustion with the sulphurous vapours emitted by the ore acts injuriously, both in retarding the oxidation and in spoiling the gaseous product. On the other hand, this furnace needs as much motive power as the Brunton, and it is difficult to understand how a gradual and steady passage of the ore particles from the centre to the periphery of the hearth can possibly be secured by the operation of gravity alone.

Another modification of the Brunton, coupled with a short reverberatory, has been adopted in California, and is shown in Fig. 12. The ore, consisting of gold-mill concentrates, carrying antimony and lead, as well as the usual sulphurets, is worked from the ordinary reverberatories on to the horizontally revolving hearth, which is built of iron lined with firebrick, measures 12 feet diameter, and has a central discharge opening. Motion at the rate of one revolution a minute is given to the rotating hearth by gearing beneath. The fire-gases have to pass across the revolving hearth before reaching the stationary hearths. The furnace possesses no obvious advantages.

Conclusions.

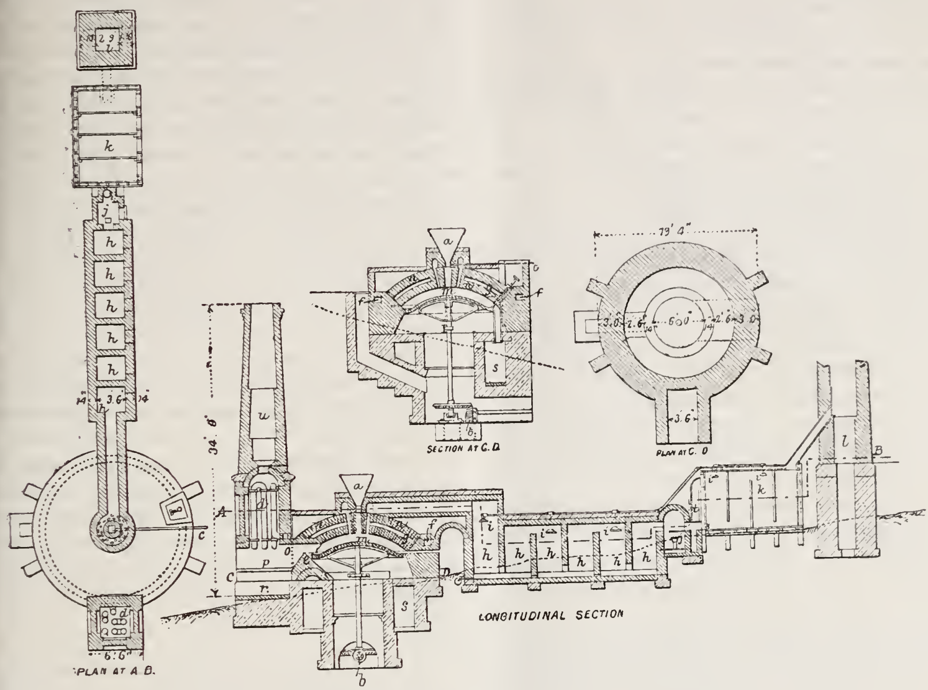
The conclusions to be drawn from a study of the foregoing observations are neither very startling nor perhaps very original, but they

ave a practical bearing on the economics of old-milling. The leading features to be riven for are:—

1. Avoidance of manual labour, making both feed and discharge automatic; utilising gravity as much as possible for movement of the ore through the furnace; and reducing the moving parts and motive-power of the furnace to minima.

2. Greatest possible economy of fuel, therefore the maximum attainable utilisation of the combustible contents of the ores themselves.

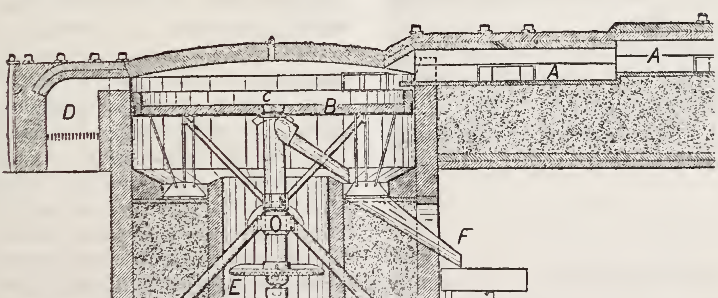
FIG. 11.



SERJEANT AND FLUDE'S FURNACE.

a, feed-hopper; *b*, driving gear; *c*, shaft of self-feeder; *d*, hot air pipes; *e*, firebridge; *f*, hot air flue; *g*, air chamber in crown of furnace; *h*, condensing chambers; *i*, steam jets; *j*, nitric oxide generator; *k*, leaden sulphuric acid chamber; *l*, chimney; *m*, hearth; *n*, crown; *o*, damper; *p*, fireplace; *r*, ash pit; *s*, roasted ore pit; *t*, flue to acid chamber; *u*, furnace chimney.

FIG. 12.



CALIFORNIAN REVOLVING HEARTH.

A, ordinary reverberatories; B, revolving hearth; C, central aperture; D, fireplace; E, motive wheels; F, discharge.

3. Provision of an abundance of oxygen, in the form of heated fresh air, accomplishing this by taking advantage of the waste heat of the furnace, and not consuming fuel specially for that purpose.

4. Most complete exposure of every particle of ore to the heated air.

5. Simplicity and economy in construction of furnace; fewness of wearing and working parts, which should be easily duplicated; and general accessibility for repairs.

6. Utilisation of all products of the operation, so far as that is possible.

Considering the great variety of gold-bearing ores that have to be dealt with, it is hardly likely that one form of furnace will be found to meet all requirements with a maximum degree of efficiency. For instance, though fine crushing would much hasten oxidation, it is not always admissible, on account of subsequent treatment. Then the per-centage of combustible matter (sulphur, arsenic, &c.) in the ore must have an important bearing on the form of the furnace. Again, the quantity of material to be dealt with may have to be considered: few mills produce sufficient concentrates to fully occupy any of the mechanical furnaces described, and this fact seems to have helped prolong the survival of the hand-worked reverberatory in many places, although that would seem to be a poor excuse for such costly manipulation as it entails.

Speaking generally, I am inclined to think that the several kinds of furnace will have their most useful spheres defined by the following conditions:—

For finely-ground (40 mesh and finer) clean sulphurets, in which absolute sweetness is not essential, a shaft furnace.

For coarsely-ground (less than 40 mesh) sulphurets, and for only moderately sulphuretted ores, a revolving cylinder.

For any ore which requires an absolutely sweet roast, a mechanical rabbler with fixed hearth.

DISCUSSION.

The CHAIRMAN said he had listened with the greatest interest to this paper, because, although he was familiar in a general way with these appliances, still hearing about them from the lips of so experienced a man as Mr. Lock brought to the mind very forcibly how many details there were in conducting even such a very simple operation. It was interesting to hear that such an old friend as the long-bedded reverberatory furnace was still considered a very efficient appliance. There was nothing more remarkable than to stand by a furnace such as those used by his friend, Mr. Pearce of Denver, in which he converted the mixed sulphides into sulphates. For instance, in the case of sulphide roasting for subsequent solution as sulphate of silver, the way in which the operator would convert all the sulphides into sulphates, and then, by a judicious rise of temperature, split up those various sulphates until sulphate of silver was left undecomposed, was perfectly marvellous. Judging by the mere colouring streak from the furnaces, the actual stage which had been reached was as delicate a manipulative operation as any he knew of. If he remembered aright, when he was there in 1868, Mr. Pearce did not fill up the space beneath the bed of the reverberator with rubble, but made the walls hollow and admitted air beneath the bed, thus keeping the bed cool, and obtaining many of the advantages of a regenerative furnace with a gas producer. He did not produce gas in a separate generator, but he had practically the advantages both of regeneration and of gaseous fuel. No reference, he noticed, had been made to the muffle furnaces which, in accordance with the Alkali Act, was in this country necessary under some conditions; but he could not help being greatly interested in the Pearce "turret" furnace, which in some way suggested the Hofmann kiln, and really led one to wonder if it could not be modified, so as to obtain the same advantages.

Mr. C. J. FAUVEL said the furnace which bore his name was essentially a shaft furnace, and was designed to rapidly oxidise sulphides; but there was one little point about it which had not been mentioned. While it was heated to a temperature of say 1,200° or 1,300° at the bottom, there was a great decrease of temperature towards the top; and when the ore was fed in at the top by a patent automatic apparatus in a thin sheet, and distributed over the rabbling shelves, it met a gradually increasing temperature, and an increasingly pure oxidising medium as it descended; the shelves were made of a special composition, over which the ore slipped very quickly. As Mr. Lock had said, the oxidation of a particle of pyrites could be accomplished in a minute, and the ore was in this furnace about two minutes, having about 49 feet to fall from side to side, gradually getting hotter on its way. The point Mr. Lock had omitted was, that when the ore reached the state of incandescence, it met with sprays of water. When ore was examined in its first stage, as taken from a roasting furnace, it was sometimes found that oxide of iron and other matters were adhering to the gold; and when you came to amalgamate with a pan or a table, there was a considerable loss through these films preventing amalgamation. After a series of experiments, both in Africa and at Hackney Wick, he came to the conclusion that if the ore could be roasted to a very high temperature, and then plunged into cold water, these films would

be removed. He found, however, that still water would not do, so he introduced a number of spray pipes which were not shown in the drawing. When the ore came in contact with the water, it was suddenly reduced from a temperature of 1,500° to probably 100°, and then the water itself carried the ore into a distributor box, and thence to the amalgamators. There was no necessity for barrows or little trucks. There was no additional labour required with this furnace; the mill hands could do all that was required; and very little power was needed, as the ore was put in at the top, and fell by its own gravity. The "water dodge," as it was called in America, was one of the principal features; he had sent drawings over there, and believed a furnace had been built, but he had not yet heard the details in full; but he believed it was being worked at a cost of less than 25 cents for fuel and labour. He claimed that it stood above any other furnace in point of economy. A furnace costing £1,330 would treat 40 to 70 tons per day, according to the amount of sulphur and arsenic in the ore. Once started, it would run for a long time, and required really no repairs. If you wanted to get inside you could do so by removing a small quantity of brickwork, without destroying the tower, and there were no wearing parts, except the shelves and the machinery at the top. Condensing chambers could be set in between the smoke stack and the tower, and by-products, if required, could be taken off at those points. Reverberatory furnaces, no doubt, had their merits, but when there was a large body of ore lying on the hearth, if the heat was underneath there were a great many faults, and if the heat were all on top there were other faults, because it was only the face of the ore which was operated on, and you could not be sure that every particle of ore would come in contact with both the heat and the air. In his furnace, as it came down from shelf to shelf, it was rolling over and over all the way to the bottom. Even in the mechanical furnaces the ore was in bulk, and it did not come down in a fine sheet or shower. Where the products of combustion came in contact with the ore there were many defects, all sorts of hydrocarbons formed films on the gold, as well as on the ore, and prevented that intimate contact with the mercury which was so necessary. Where roasting was done simply with the object of chlorinating afterwards, no doubt they would be largely employed, but where amalgamation was the object, he held that his furnace would take the lead. Several had been erected in Africa and on the Continent, one in California, and one would soon be put up in the neighbourhood of London. On the Continent they had been experimenting with it for the treatment of auriferous antimony ores, and in California they had proposed to modify it a little for the treatment of cinnabar.

Mr. H. C. JENKINS said that the general classification of roasting furnaces was a little incomplete, owing to the absence of the muffle furnaces, a type with which Mr. Gibbs's name was identified. One of the furnaces (Fig. 6) did, however, resemble the muffle in some respect, but with a rotating cylinder, heated, as it had to be, from the outside, it could not commend itself much to practical men. The author, in his paper, had made reference in a somewhat disparaging way to the Stetefeldt furnace as being but a crude representative of its class. No doubt in that particular furnace, the conditions were not very favourable to complete roasting, but shaft furnaces could be efficient, even when not economical. Bainbridge's furnace which was a heated vertical tube, in which a gentle current of air rises, is said to be capable of completely oxidising metallic lead or zinc during the short time it would take to fall about ten feet. By using a more rapidly moving column of heated air, it has recently been found possible in some experimental work at Kensington, to completely oxidise sulphides, even when falling through a hot zone that could not be made more than two feet high. The fall of the particles was, a great extent, arrested, and it was found necessary to pass the material twice through the tube, but even then the total time of exposure of the particles could not be more than twenty seconds. The modified Oxland and Hocking calciner, at use in Swansea, was capable of a more complete roasting than was actually performed, but was working in copper regulus, which was rather fusible.

Mr. T. CLARKSON said when he was in Chicago, two years ago, he saw Mr. Brown, who had devoted a great deal of attention to the improvement of the turret furnace, and he showed him some of the recent drawings, but he could not say much of the two special novelties which he claimed to be advantages over Mr. Pearce's type. He understood that this system of roasting continuously by the mechanical means, on a long reverberatory bed, was found to be most efficient. They could all see the great advantage of a gaseous fuel furnace, where the material was continually being exposed to the atmosphere, but he did not know whether it would be, on the whole, so efficient as a reverberatory system on a proper mechanical basis, with all the details properly worked out.

Mr. FAUVEL desired to add that in his furnace the air was heated before being admitted into the bottom of the furnace, and that on the heated ore falling into the spray of water, a certain quantity of steam was generated, which ascended and assisted in the oxidation of the pyrites.

The CHAIRMAN, in proposing a vote of thanks to Mr. Lock, said he had seen in California a shaft furnace very much like Mr. Fauvel's in general arrangement, used for roasting sulphide of mercury ores, but the shelves were arranged in a different manner; in fact, the whole apparatus seemed one mass of shelves; as soon as the ore got off one shelf it was on another.

The vote of thanks having been carried unanimously,

Mr. Lock, in reply, said the subject did not seem to attract very much attention, whether it was owing to the increasing importance of the cyanide process, or to the fact that most of those who had any experience in treating gold ores were better occupied in South Africa, or Western Australia, he could not say. There was a very great deal to be said in favour of Mr. Fauvel's furnace, and it was perhaps just as well that he had left something for the author himself to say. He had something to do with suggesting improvements in it in its early stages, and he must say that on the experimental scale they got excellent results when dealing with highly sulphuretted or arseniuretted ores, which almost entirely supported their own combustion, and in such cases it was very economical. Mr. Fauvel was perfectly justified in referring to the subsequent treatment of the ore, but he had not dealt with that in the paper because the quenching of the ore really had nothing to do with the apparatus in which the roasting was conducted. He made some experiments in America in discharging roasted ore from the end of an Oxland or Howell-White furnace into cold water, and was much disappointed in the result. Amalgamation was not aided in the slightest degree; in fact, if anything, it was slightly worse than when the ore was allowed to lie in the pit. That might be partly due to the fact that lying in the pit helped to complete the oxidation, and rendered the gold more easily amenable to the mercury. The ore also was only crushed to 8-mesh and was not highly sulphuretted. He did not say more than he had about the Fauvel furnace because, as he had mentioned, they had as yet no working results from any goldfield, such as he hoped would soon be forthcoming. But whatever trouble you took in the construction of a shaft furnace, you could not control the rate or degree of oxidation; if it was purely automatic, when the ore reached the bottom it had to be cast out, whether it was done or not. Mr. Jenkins rather took exception to his reference to the Stelefeldt furnace; he did not mean to decry it, in its legitimate sphere, but as a shaft furnace it was rather crude, because the ore simply fell in one mass, instead of being broken up and scattered, and so brought into intimate contact with the air and heat, which together effected the oxidation. The experience of obtaining complete oxidation of a metal, by dropping it through a small space, was hardly a parallel to the treatment of ores. Unless the size of the particles were adjusted to the force of the upward current, there must have been a very large portion carried over as flue dust, which was one of the great difficulties to be met in all these furnaces. Different conditions required slightly different furnaces, and he did not regard any as being best for all purposes; but he had endeavoured to give a fair account of the most important classes.

Miscellaneous.

CONGRESS OF VIENNA EXHIBITION.

Information has been received from the Foreign Office, through the Science and Art Department respecting a proposed Exhibition to be held at Vienna between the months of January and May, 1896, to reproduce the period of the Congress of Vienna. The following letter from the Austro-Hungarian Ambassador at the Court of St. James's to the Secretary of State for Foreign Affairs, which has been communicated for publication, contains full particulars of the object aimed at in the scheme of the exhibition.

Belgrave-square,
February 5th, 1895.

My Lord,—I am informed by my Government that it is intended to hold an Exhibition, to be called the Congress of Vienna Exhibition, between the months of January and May, 1896, in the Imperial and Royal Museum for Arts and Industry at Vienna. A Special Committee has been formed to carry out this enterprise, under the presidency of the Grand Master of the Huntsmen, Count Hugo Abensperg-Traun, and has undertaken to collect the objects for exhibition, as well as to carry out the historical, scientific, and artistic examination and arrangement of the material contributed.

This Exhibition is to bring under view the historical, biographical, and social recollections of the period of the Congress of Vienna, and supply an instructive review and picture of the productions of the arts and manufactures at the beginning of this century—from about 1800 to 1820.

As this undertaking could not be carried out completely with the objects of the class indicated, which are to be found in Austria alone, the Committee considers it most important to draw upon foreign collections, both public and private, for exhibits.

The Imperial and Royal Government has, therefore, directed me to endeavour to interest her Majesty's Government in this Exhibition, I have, then, the honour to request your Excellency's kind consideration of the wishes and desires which may later on be expressed to her Britannic Majesty's Government by the Exhibition Committee and the Austrian Museum respectively.

I venture to add that the Committee intends, when collecting objects for the Exhibition, to send experts and officials of the Austrian Museum to the spot. I enclose a number of programmes of the Exhibition and lists of the Committee.

I have, &c.,

(Signed) F. Deym.

The Earl of Kimberley, K.G., &c.

Notes on Books.

HATS ON INVENTIONS. By John Martin. London: Offices of *Invention*. 1894.

Mr. Martin has adopted for his manner of instruc-on the time-honoured method devised by Mrs. Markham. He imagines a lot of young people with an intelligent schoolmaster who hold conversation on matters connected with elementary mechanics and physics, and are thereby led on to study the history of invention, and to profit by the examples inculcated. The book is written in a very popular style, and can be recommended to young people with a taste for mechanics.

HYGIENE. By J. Lane Notter, M.D., and R. H. Firth, F.R.C.S. London: Longmans, Green and Co. 1894.

The authors of this treatise take a very wide view of the limits of their subjects. There is no doubt that the study of sanitary science includes a very wide range, and a knowledge of it must include a comprehensive acquaintance with a number of very different sciences; but even with this consideration, there is certainly a good deal in this book, more than the ordinary reader might have expected to find. In addition to full information on such subjects as heating, warming, and ventilation, drainage of houses, sewerage of towns, water supply and other kindred matters, we find chapters upon food, infectious diseases, parasites, climate, and vital statistics. It will, therefore, be seen that the manual is a very comprehensive one, and if it errs at all, it errs on the right side of giving rather too mnch than too little information. The chapter on meteorology might, perhaps have been condensed, or even omitted, and the space thus obtained utilised for a fuller treatment of sanitary subjects proper. But for those who desire to familiarise themselves with the subject generally, the wide range taken by the authors will be an advantage, and there are of course many special works which treat in detail the subjects of which the present work gives a very excellent summary.

THE UNIFICATION OF LONDON: The Need and the Remedy. By John Leighton, F.S.A. London: Elliot Stock. 1895.

The author proposes to divide London into 2-mile hexagons with the City as the central division. He has arranged 19 of these areas with power to increase these outside as the circle of the town increases. They are: 0, City; 1, Islington; 2, Bethnal Green; 3, Southwark; 4, Kennington; 5, Westminster; 6, St. Pancras; these six form the Inner Circle. The Outer Circle consists of 1*a*, Hornsey; 2*a*, Hackney; 3*a*, Old Ford; 4*a*, Poplar; 5*a*, Deptford; 6*a*, Peckham; 7*a*, Brixton; 8*a*, Battersea; 9*a*, Chelsea; 10*a*, Marylebone; 11*a*, St. John's Wood; 12*a*, Kentish Town. Another circle, which has not been numbered, would consist of Tottenham, Stamford Hill, Leyton, Forest Gate, West Ham, Blackwall, Greenwich, Lewisham, Forest Hill, Norwood, Balham, Wandsworth, Fulham, Kensington, Paddington, Willesden, Hampstead, Highgate. Each of these areas would constitute a separate and independent district, to be called a borough, possessing a representative body having the control of its own affairs; the County Council to consist of four representatives from each body. Each hexagon could be divided into equilateral triangles and numbered; and Mr. Leighton would have these letters and numbers marked on the street lamps. This mode of division would simplify the calculation of cab fares, and if the Inner Circle was indicated by red and the Outer by blue, cabs could carry a coloured side-light, as in Paris, indicating their district. Omnibuses and tramcars might be made to indicate the route of their journey by a board marked with the colours of the districts traversed. In this little book a map of each district is given, with the boundaries, places of importance, open spaces, &c., noted.

DESCRIPTIVE ZOOPRAXOGRAPHY. By Eadweard Muybridge, University of Pennsylvania. 1893.

Mr. Muybridge was certainly the pioneer of the system now, by the advance of the science, very much developed, of observing the motion of animals by means of photography. Members of the Society will recollect the interest which was aroused by the lecture on the subject which he gave before the Society in 1882. His first experiments date back to 1872. At that time only the comparatively slow, wet collodion plate was available, yet the work which under considerable difficulties, and with apparatus which we should now consider of a rather clumsy nature, Mr. Muybridge effected is certainly quite as remarkable as anything which has since been done. The figures he produced were nothing more than silhouettes, but they showed for the first time the actual positions taken up by horses and other animals in their various gaits. The present little book gives an account of the apparatus set up at the University of Pennsylvania for the examination and record of the movements of various animals. Not only was Mr. Muybridge the first to obtain correct figures of animals in rapid movement, but he was the first to devise a method for projecting moving figures on the screen. By the aid of the instrument which he has somewhat clumsily named the Zoopraxiscope, he was enabled to reproduce by the combination of a succession of photographs the series of movements, of which one stage was represented by each photograph. More elaborate devices have since been invented for the same purpose, and by the great improvement in photographic plates, means have been provided by which, instead of mere outlines against a background, figures with full detail can now be expected.

Turning Lathes. By James Lukin, B.A. Britannia Company, Colchester. 1894.

This is the fourth edition of a work issued by the Britannia Company, who are makers of lathes and tools for amateurs. It gives the usual elementary instruction in turning, and a variety of information likely to be useful to the mechanical engineer. Being issued by a mechanical firm it is no doubt principally intended to illustrate the use of the tools supplied by the firm, but the elementary instruction included is likely to be equally serviceable to any mechanical amateur.

Obituary.

Lord Aberdare, G.C.B., F.R.S.—The Right Hon. Henry Austin Bruce, first Lord Aberdare, who died on Monday, 25th February, at his London residence in Prince's-gardens, was a member of the Society of Arts from 1866, and a Vice-President 1867-69, 1876-79. He was interested in the work of the Society and presided at meetings on several occasions. He was born April 16th, 1815, and was called to the bar in 1837. In 1847 he was appointed police magistrate for Merthyr Tydfil and Aberdare, and in 1852 he commenced his political career and entered Parliament as member for Merthyr; this seat he held for sixteen years. At the end of 1868 he was appointed Home Secretary in Mr. Gladstone's Ministry, and was at once elected member of Parliament for Renfrewshire. In 1873 he was raised to the peerage, and succeeded Lord Ripon as President of the Council. In the following year the Government resigned, and Lord Aberdare did not again take any prominent part in political affairs. His life, however, continued to be a very active one; he was President of the Social Science Congress in 1875, and President of the Royal Geographical Society in 1883. He was also President of the Royal Historical Society, and took an active part in the Domesday Commemoration which was so successfully carried out by that Society in 1886. He was described by Mr. Rathbone at a deputation to Mr. Acland, in the early part of last year, as the "father of Welsh education," and he took a leading part last year in the reconstitution of the new University, of which he was Chancellor.

General Notes.

National Health Society.—A course of six lectures on "Domestic Economy and Household Management," was commenced by Mrs. Dickson, in the Committee-room of the National Health Society, 53, Berners-street, W., on Thursday, Feb. 21st, 1895, at 3 p.m. The subjects of the lectures are as follow Lecture I.—Thursday, Feb. 21st, "How to get best out of Life." Lecture II.—Thursday, F 28th, "The Home and the Pleasures and Rewa of Economy." Lecture III.—Thursday, March 7, "The Home, its Comfort and Beauty." Lect IV.—Thursday, March 14th, "The Art of Dress Well and Cheaply." Lecture V.—Thursd March 21st, "Food Supplies." Lecture VI Thursday, March 28th, "Wages. How to spe them."

Welding of Iron and Steel.—At a meet of the Royal Society on the 21st inst., a paper "Iron and Steel at Welding Temperatures," by M T. Wrightson, M.P., was read. The object of paper was to demonstrate that the phenomenon welding in iron is identical with that of regelation ice. The author recapitulated some experime which were made by him in 1879-80 upon cast ir and proved the fact that this form of iron posses the property of expanding while passing from t liquid to the plastic state during a small range temperature, and then contracts to the solid sta and that the expansion amounts to about 6 per cen in volume. This property of iron resembles t similar property of water in freezing, which, within range of about 4° C., expands about 9 per cent. of liquid volume, and then contracts as the cooli proceeds. Subsequent investigations at the Mi appeared to prove that wrought iron at a weldi temperature possesses the same property of cooli under pressure which was proved by Lord Kelvin exist in freezing water, and on which demonstratio the generally received theory of regelation depend The author distinguished the process of meltir together of metals from that of welding. Eith process forms a junction, but the latter takes place a temperature considerably below the melting poin The well-known and useful property of welding i iron appeared, therefore, to depend, as in the case o regelation in ice, upon this critical condition, whic exists over a limited range of temperature betwee the molten and the plastic state.

Strasburg Industrial Exhibition. — A Exhibition, intended to show the industrial capacit and progress of Elsass-Lothringen, the Grand Duch of Baden, and the Bavarian Palatinate, is announce to open at the Orangerie, Strasburg, on the 15th o May next, and to remain open until the 15th o October following. The classification embrace twenty groups:—I. Agricultural Produce, includin textile substances and dye plants. II. Products o Forestry—Timber of all kinds and its various applications. III. Mines and Saltworks—Ores, fuels asphalte, and petroleum. IV. Stone and Earth—Natural and artificial building materials. V. Works—Iron and steel making and their products, as well as those of other metals and their alloys. VI. Engines and Machine—Motors, railway plant, and

machine tools. VII. Building and Engineering—Bridges, railway construction, gas and electric lighting, water supply and heating apparatus. VIII. Chemical Industry, including the utilisation of by-products and artificial manures. IX. Food Products. X. Textile Industry. XI. Wearing Apparel. XII. Leather and India-rubber Wares. XIII. Paper-making. XIV. Earthenware and Glass. XV. Articles made of wood, bone, horn, and their imitations. The Exhibition is under the patronage of Prince Von Hohenlohe-Schillingsfürst, Statthalter of Elsass-Lothringen; while the president of the executive committee is Herr Back, burgomaster of Strasburg; the vice-president, Herr Schaller, vice-president of the Chamber of Commerce; and the secretary, Herr Eissen.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock:—

March 6.—"Cider." By C. W. Radcliffe Cooke, M.P. Sir George Birdwood, K.C.I.E., will preside.

March 13.—"The Meat Supply of the United Kingdom." By E. Montague Nelson. Sir Frederick Bramwell, Bart., D.C.L., F.R.S., will preside.

March 20.—"The Progress of the Abattoir System in England." By H. F. Lester, Hon. Secretary to the London Model Abattoir Society. Sir Benjamin W. Richardson, M.D., F.R.S., will preside.

March 27.—"Modern Photogravure Methods." By Horace Wilmer.

April 3.—"Sand Blast Processes." By John J. Holtzapffel.

Papers the dates of which are not fixed:—

"The Use of Aluminium in the Separation of Metals from their Oxides." By Professor William Chandler Roberts-Austen, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. Charleton, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. Crompton, M.I.E.E.

"Electric Lighting of Ecclesiastical Buildings." By Major-General Charles E. Webber, C.B.

"Improvements in Milling Machinery." By J. Harrison Carter.

"Deviations of the Compass." By Professor A. W. Reinold, F.R.S.

"Means for Mitigating the Fading of Pigments." By Captain W. de W. Abney., C.B., F.R.S.

Afternoon Lecture.

Thursday, March 14, at Half-past Four.—"Art Tuition." By Prof. Hubert Herkomer, R.A.

Indian Section.

Thursday Afternoons, at Half-past Four o'clock:—

March 28.—"Chitral and the States of the Hindu Kush." By Capt. F. E. Younghusband, C.I.E. The Hon. George Curzon, M.P., will preside.

April 25.—"The Coming Railways of India, and their Prospects." By J. W. Parry, A.M.Inst.C.E., late Executive Engineer Indian State Railways.

May 23.—"Punjab Irrigation: Ancient and Modern." By Sir James Broadwood Lyall, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

Foreign and Colonial Section.

Tuesday evenings, at Eight o'clock:—

March 5.—"Colonies and Treaties." By Sir Charles M. Kennedy, K.C.M.G., C.B.

April 2.—"Commercial Education in Belgium." By Professor William Layton.

April 30.—"Madagascar." By Captain S. Pasfield Oliver.

Applied Art Section.

Tuesday Evenings, at Eight o'clock:—

March 19.—"Carpet Designing." By Alexander Millar. J. Hungerford Pollen will preside.

April 23.—"Art of Casting Bronze in Japan." By William Gowland. Prof. W. C. Roberts-Austen, C.B., F.R.S., will preside.

Cantor Lectures.

Monday Evenings, at Eight o'clock:—

Dr. D. Morris, C.M.G., "Commercial Fibres." Three Lectures.

March 18.—Lecture I.—Cellulose and non-cellulose constituents of fibres—Chemical tests for cellulose—Comparative estimation of fibres—Pure cellulose in cotton, kapok, vegetable silks, and seed-hairs—Bast fibres of dicotyledonous plants—Fibre-bundles and ultimate fibre-cells—Higher textile fibres: Flax—Hemp—Calotropis—Sunn-hemp—Marsdenia—Sida—Nettle fibres: China-grass—Rhea—Nilgiri nettle—Pua-hemp—Ban-rhea—Urera—Lower textile fibres: Indian jute—Chinese jute—American jute—Abroma—Abutilon fibres—Deccan hemp—Roselle fibre—Ban-ochra—Helicteres—Pavonia and malvaviscus fibres.

March 25.—Lecture II.—Fibro-vascular bundles in monocotyledonous plants—Bast fibres and vessels—Disposition of bundles in stems and leaves—Component fibres—Ultimate fibres—Manila (plaintain) hemp—Sisal hemp—Bahamas pita—Mauritius hemp—Bombay aloe fibre—Manila aloe fibre—Mexican brush fibre—New Zealand hemp—Yucca

fibre from stem and leaves—Bowstring hemps—Somali-hemp—Pineapple fibre—Caraguatá hemp from Argentine—Pinguin fibre—Karatas or hammock fibre—Oil-palm and other palm-leaf fibres.

April 1.—Lecture III.—Piassava brush fibres—Bahia—Para—Kitool—Palmyra—West African—Madagascar—Cocoa-nut coir-yarn—Coir-fibre—Coir-rope — Coir-bristle — Curled palm fibre — Spanish moss — Epidermal palm fibres — Raphia — Paper materials—Esparto—Spanish—Algerian—Tunisian—Indian Bhabur grass — Paper mulberry — Siam streblus bark—Adansonia or Baobab bark—Mechanical and chemical wood pulp—Common basts—Russian bast—Cuban bast—Lace-bark bast—New and old fibres—Improvements in fibres—Cultivation—Selection—Mechanical and chemical extraction—Summary.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 4...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Palace Hotel, Victoria-street, S.W., 7½ p.m. Messrs. W. Worby Beaumont and Stephen Sellon, "Parliamentary Procedure as affecting Light Railways and Tramways."

Chemical Industry (London Section), Chemical Society's Rooms, Burlington-house, W., 8 p.m. 1. Mr. A. P. Laurie, "The Durability of Pigments derived from Coal-tar Products." 2. Sir Henry Roscoe and Mr. Joseph Lunt, "The Hermite System of Sewage Purification."

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. Clements R. Markham, "The Antarctic Expedition from a Colonial Point of View."

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned discussion on Mr. A. C. Pain's paper on "Light Railways."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Paper on "Comtes Philosophy."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Edward E. Klein, "Theory and Practice of Protective Inoculations."

Tuesday, March 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Sir Charles Kennedy, "Colonies and Treaties."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "Internal Framework of Plants and Animals." (Lecture VIII.)

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Sanitary Institute, 74a, Margaret-street, W., 8 p.m. Prof. A. Wynter Blyth, "Sanitary Lawsand Regulations governing the Metropolis."

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. Robert Robertson, "Electric Haulage at Earnock Colliery." 2. Mr. Robert Hay, "Water-power Applied by Electricity to Gold-Dredging."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. F. E. Beddard, "Preliminary Account of New Species of Earthworms belonging to the Hamburg Museum." 2. Mr. A. D. Michael, "A New Hydrachnid found in Cornwall, with a Study of its Internal Anatomy." 3. Rev. W. J. Holland, "A Synonymic Catalogue of the *Hesperiidæ* of Africa and the adjacent Islands, with Descriptions of some apparently new Species."

Wednesday, March 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. C. W. Radcliff Cooke, "Cider."

Geological, Burlington-house, W., 8 p.m. 1. Messrs. J. D. Duckworth and F. E. Swainson, "A New Ossiferous Fissure in Creswell Crags." 2. Prof. J. B. Harrison and Mr. A. J. Jukes-Browne, "Notes on the Chemical Composition of some Oceanic Deposits."

Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. Roland Trimen, "Some new species of Butterflies from Tropical and Extra-tropical South Africa." 2. Mr. G. A. James Rothney, "Notes on Indian Ants." 3. Mr. Oswald H. Latter, "Further notes on the secretion of potassium hydroxide by *Dicranura vinula* (imago), and similar phenomena in other Lepidoptera."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

Mining and Metallurgy (in the Lecture Theatre of the Geological Museum, Jermyn-street, S.W.), 8 p.m. 1. Discussion on Mr. H. Livingstone Sulman's Paper, "Some Improvements in Gold Extractions." 2. (*a*) Mr. J. A. Jones, "The Covadonga Manganese District and its Mines;" (*b*) Mr. Frank Johnson, "The Manganese Deposits of Huelva;" (*c*) Mr. Ernest R. Woakes, "Notes on the Espiritu Santo Mine at Cana."

Thursday, March 7...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. Maxwell T. Masters, "The Genus *Cupressus*." 2. Messrs. W. F. Kirby, Chas. Gahan, and R. I. Pocock, "The Insects, Arachnida and Crustacea, collected during Mr. T. O. Bent's Expedition to Hadramant, Arabia."

Chemical, Burlington-house, W., 8 p.m. Dr. Kipping, "Dimethylketohexamethylene."

Royal Institution, Albemarle-st., W., 3 p.m. Prof. S. R. Gardiner, "Three Periods of 17th Century History." (Lecture I.—The Stuart Monarchy.)

Imperial Institute, South Kensington, S.W., 4½ p.m. Prof. James Long, "Our Dairy Industry."

Camera Club, Charing-cross-road, W.C., 8 p.m. Mr. H. E. Davies, "A Homily on Lantern Slides."

Friday, March 8...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. A. W. Rucker, "The Physical Work of Von Helmholtz."

Sanitary Institute, 74a, Margaret-street, W., 8 p.m. Dr. J. F. Sykes, "Objects and Methods of Inspection."

Astronomical, Burlington-house, 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Exhibition by Mr. Naber of a Voltmeter; Dr. G. Johnstone Stoney—"The Focal Heliostat;" "An Improvement in Siderostats." 2. Mr. G. U. Yule, "A New Harmonic Analyser." 3. Mr. H. N. Allen, "The Electromagnetic Field."

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. (Students' Meeting.) Mr. A. Struben, "The Co-ordinate System of Surveying, as Employed in South Africa."

Saturday, March 9...Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Waves and Vibrations." (Lecture II.)

ournal of the Society of Arts.

No. 2,207. Vol. XLIII.

FRIDAY, MARCH 8, 1895.

l communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PECIAL AFTERNOON LECTURE.

Professor Hubert Herkomer, R.A., ll deliver a lecture on "Art Tuition," on ıursday Afternoon, 14th inst., at Half-past ɔur o'clock.

THE ALBERT MEDAL.

The Council will proceed to consider the vard of the Albert Medal for 1895 early in ay next, and they, therefore, invite members the Society to forward to the Secretary, on before the 13th of April, the names of such en of high distinction as they may think ɔrthy of this honour. The medal was struck reward "distinguished merit for promoting rts, Manufactures, or Commerce," and has ɜen awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., for his great services to Arts, Manufactures, and ɔmmerce, in the creation of the penny postage, and r his other reforms in the postal system of this ıuntry, the benefits of which have, however, not ɜen confined to this country, but have extended over ıe civilised world."

In 1865, to his Imperial Majesty, Napoleon III., for distinguished merit in promoting, in many ays, by his personal exertions, the international ɾogress of Arts, Manufactures, and Commerce, the roofs of which are afforded by his judicious patronge of Art, his enlightened commercial policy, and specially by the abolition of passports in favour of ritish subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., for discoveries in electricity, magnetism, and ıemistry, which, in their relation to the industries the world, have so largely promoted Arts, Manuctures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill ooke and Professor (afterwards Sir) Charles Wheatone, F.R.S., "in recognition of their joint labours establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the applications of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S., "because of

his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., P.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (now Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (now Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry —the utilisation of waste silk."

In 1887, to Her Majesty the Queen, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures, and Commerce, through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to William Henry Perkin, F.R.S., "for his discovery of the method of obtaining colouring matter from coal tar, a discovery which led to the establishment of a new and important industry, and to the utilisation of large quantities of a previously worthless material."

In 1891, to Sir Frederick Abel, K.C.B , D.C.L., D.Sc., F.R.S., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the application of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

In 1892, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S., "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted."

In 1894, to Sir Joseph Lister, Bart., F.R.S., "for the discovery and establishment of the antiseptic method of treating wounds and injuries by which not only has the art of surgery been generally promoted, and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, February 26, 1895; Alan S. Cole in the chair.

The paper read was—

MEDIÆVAL EMBROIDERY.

By Miss May Morris.

I come here to-night with a subject so interesting, so closely knitted with the

romance and with the reality of mediæval life, that I am confident no blundering of mine can altogether deprive it of its charm, or send you away with the feeling of an evening utterly ill-spent. I wish to put before you an aspect of the art of needlework which shall be a serious one—serious, so far that it has nothing in common with the graceful frivolities which bric-à-brac dealers catalogue as "ancient embroidery" though they are very seldom older than the 18th or 17th centuries. We shall go back to a period when, as far as we can tell, needlework decoration seems to have reached its best and most intellectual development,—when it had its recognised guilds and schools, its famous workers, and its master-pieces. Precious indeed, must these have been in all ages, for their frail webs to be preserved down to the present day. And if I ask you to wander with me among the mazes of the fanciful word-painting of old romance-writers, I promise that you shall not be wearied; for it is worth our while to make for ourselves a clear picture of the characteristics, the temper and vitality of an age which produced this elaborate and highly-finished needlework.

The records written in the architecture of towns and churches are those of practical every-day life; but the favourite stories of a nation, with all the fanciful flights of the writer, help us to understand more intimately the humour of the men and women who lived in those towns and thronged those churches, their tastes, their clothing, the furnishing of their houses, the stuffs they liked best, and the games they played in holiday-time; even the very food they ate. In turning to an old metrical romance, I read of a lady who spent seven years in embroidering the borders of a mantle; in another of a lady who was dressed in a stuff from beyond seas, "most marvellous and most varied; for it was neither white nor black nor blue nor green nor yellow nor vermeil; a skilful diviner could scarcely learn what nature of colour it might be." Another writer tells us of the mantle of Helen of Troy, its virtues and its many changing colours; it was worked by the dwarfs from beyond seas, and the rainbow texture was "embroidered with silk and after such fashion that never in the world before was work so finely wrought. Tame things and wild things (the marvel of it!) were found there in rich brilliance, creatures that you would have thought lived and breathed. Leaves and stems of the vine were there also sewn with spun gold; beasts, birds and fishes were on the fair cloth," and so forth sings the poet. A pretty rhapsody I find too over the love-token worked by the daughter of a king of Persia, a silken sleeve, embroidered with gold, with a motto or device traced in her own hair. "And on the right arm hung a sleeve of silk; never hear I spoken of a richer one, what so place I am in. Near the wrist was a buckle formed of two gold leopards; on everyside was it worked with flower-de-luces of gold thread, and letters around were traced with hair so fine and soft, that gold and hair seemed one, for beauty and for hue, both in the legend and in the flowers." The author adds prettily, that the rich king's daughter "gave him not half her heart, but gave it frankly and wholly." In another place, the king's daughter is found with her girls, who are making orphreys and *aumonières* or pouches, and ornaments of divers kinds.

We can have no quarrel with the romance-writer who peoples his long histories with figures that pass and repass out of the vivid sunlight of flower-enamelled meadows into the twilight of enchanted woodland, or the shade of the city walls. Fanciful and restless, sometimes, this Gothic spirit, and sometimes superabundant in matter of description, but it is worth a good deal to us to be shown the story-teller's idea of how some princess Esclaramonde was dressed, from the pearl embroidered ribbon that bound the long plaits of her hair, to the golden-trellised slippers on her feet. If he stops to count the roses on her sleeves, or to recite the verses worked on the orphreys of her gown, while he keeps her—and us—waiting, and suspends the whole action of the story, we are too charmed with the rich and varied fancy of his description to mind the pedantic minuteness of him. It is nice to know, too, that the princess dried her hands on a towel of Paris weaving, fringed and worked with gold, and that her bed was hung with green samit, woven or worked with the gayest songs of the day, words and music both. A pretty conceit, and not more far-fetched than the description from an inventory of Charles of Orleans' goods, in the beginning of the 15th century, where a sleeve is catalogued on whose length is embroidered the song beginning, "Madame, je ne suis plus joyeux," the notes being formed by small seed-pearls, I forget how many thousands of them, though the inventory clerk knows all about it. And this precision of description does not fail the romancist when he lets himself go in the clouds of fantasy and describes the wonders

of strange lands *outremer*, that unexplored country beyond seas which naturally represents fairyland and enchantment to him. And, for the bedighting of kings' palaces and the adornment of beautiful women, the wonders devised and fashioned in any earthly workshop are all too commonplace, and he heaps fairy gold on the pillars of a hero's dining-hall, and veils the bodies of kings' daughters in stuffs thrown by the shuttles of an enchanter's dark-faced slaves, as his memory serves him of strange pilgrim stories of the riches of *outremer*. If I were not bound to hurry on to my main subject, I could heap one quotation on another to illustrate the fantastic restless temper of the mediæval writer and his passionate love of colour, of the sunlit fields, of the crowded animal life of the woodlands. This exuberance of marvel piled on marvel, this complexity of detail woven upon direct simplicity of constructive plan, is only one side—and the playful side—of the mediæval temper, a temper whose boldness raised Tattershall Castle on the solitary marsh, whose indomitable courage piled up the stones of Beauvais choir, whose intellect crowned the vastness of that building with a touching beauty. The lighter works of an energy like this have their significance and their place in history, though they are now, unfortunately, so frail and so few, so faded from their former splendours.

It is easy to get a clear idea of the fitting and decorations of a rich man's house in the middle ages. Among his stuffs and goods embroidery played an important part. In the old inventories, wardrobe accounts, wills, and so forth, very accurate descriptions are made of the household stuffs of great people, and not only is it noted when the hangings, cushions, and garments and *menus objets* are embroidered, or woven, or of tapestry, but the very texture is named, the colour, and the design, which is described in its striking parts —a minuteness for which one is very grateful, but which must have made the writing of inventories no slight matter.

In 1375, the Black Prince bequeaths to his "son Richard his hangings for a hall embroidered with mermen, and a border of red and black impaled embroidered with swans, having ladies' heads and ostrich feathers;" to his wife he gave a halling of red worsted embroidered with eagles and griffins, with a border of swans; to Aleyne Cheyne a bed of camocas, powdered with blue eagles. John of Gaunt gave his daughter, the Duchess of Exeter, his white bed of silk with blue eagles displayed. Imagine the charm of this, with the play of colour on the white silk!

In 1385, Joan, Princess of Wales, bequeathed "to my dear son, the king, my new bed of red velvet embroidered with ostrich feathers of silver and heads of leopards of gold with boughs and leaves issuing out of their mouths." Edward, Earl of March, 1380, leaves "our large bed of black satin embroidered with white lions and gold roses with escutcheons of the arms of Mortimer and Ulster."

These give a pretty notion of the gorgeousness of mediæval domestic hangings. Then we get such items as these:—A pillow of white silk embroidered with little pearls (Inv. Henry V.), two pillows of green satin embroidered with pearls (*ibid*), a doser for a hall, a blue hanging worked with roses, bordered with white and red of trellises and arms, with side-pieces to match (*ibid*). One item, which I cannot forbear giving in the original French:—"3. Quisshons coverez avec bald d'or bloy, stuffez avec down." This is surely the French of Stratford atte Bowe! And when a suite for a bed or a room, or a chapel-hanging or a priest's cope, was particularly smart, it was known affectionately and familiarly by the name of its distinguishing decorations. For example, a bed furniture belonging to Henry V. is mentioned as the bed "called the bed of embroidered figges, con Testur, celur and counterpayne, and iii curtaynes of old red Tarterin." Another counterpayne was called "the Hawking." We get, too, "Item, 3 copes called the Golds. Item, 13 blue copes called the Roots. Item, 13 copes of blue silk called the Georges. Item, 7 copes of blue bandekyn called the Hyndes." (Peterborough Cath.) Henry V. had, among many other delightful things, 12 cushions of lavender, which reminds one of Sir John Falstolf's inventory of goods, among which I remember a "little quisshuyn of green silk, stuffed within with lavender." I will only linger a very little longer over the romance of these old inventories; time enough to tell of some of the clothes of Richard II., who was, I believe, a very smart man, and of some of the embroidered trifles, the *menus objets*, and *mignardises*, over which our friends, the romance-writers, spend so much ingenuity. Certain long gowns, with large sleeves, of Richard II., are thus inventoried: "One of sanguine cloth in grain, and the other of white worked in embroidery in braunches of rosemary and broom, of Cyprus gold and silk." From the

treasury of Edward I. I pick the following charming item:—A kerchief (they call it a "mowscher") with leaves of gold and pearls in a casket of coral which belonged to the Queen Consort. And the odds and ends of personal adornment, the *gages d'amour*, the pouches, the gloves and shoes and head-ribbons; the strange girdles, set round with a love-song to fair maids; all the delicate trifles dear to women are fairly set down in our records. The *aumonières sarrasinoises* mentioned before were a favourite caprice in the 13th and 14th centuries, and occupied a whole craft community of men and women. They were pouches carried at the girdle, of which the romance-writers have much to say; very richly worked, whether embroidered or made of tapestry, and apparently of Eastern origin. A wedding present, made in the 14th century, was a bag "worked in an island of the seas; two years a pagan woman took in its devising." Needle portraits, too, were fashionable—of so striking a likeness, sometimes, that a young lady wishing to identify the knight Gawaine, looks for and compares with his living face the portrait of him worked by a Saracen woman, and finds it absolutely resembles him. A few of these still remain in our museums as a model of the skill and taste of three or four centuries ago.

But it is easy to see that while such ornamented stuffs for domestic use wore out, and have left us their record only in the clerk's manuscript, the more important embroidery devoted by a people ungrudging of their time and skill to the decoration of their churches and ceremonial appointments, had a greater chance of being preserved and handed down from age to age, though one must sorrowfully admit that little even of that remains for our curiosity and admiration. Such gifts—the best that might be—of gold and gems and strange shining stuffs, might well outlast the decoration of coat or mantle, whose storied border, dropped by a careless hand, got frayed, and perished on the dusty dancing-floor, or lost its brightness in the mud of a summer's rain. Too often such gowns were cut and re-fashioned in relentless disregard to the curtailing of gay flowers and the destruction of pearl-surrounded gems. These and the lesser glories of domestic embroidery, the bankers or seat-cushions; the cloths for tables and dressers, hangings for windows and settles; the bed furniture, worked with coat armour and devices; the hallings, whose roses and trellises brought the freshness of summer woods into the fire-lit dusk of the winter hearth, these and all the thousand and one odds and ends have been worn away by sheer use, eaten by moth, wasted perhaps by the carelessness of plenty, while the work done to the honour and glory of God has, in its bounty of gold and close stitches, occasionally been saved from the wear and tear of time. I wish to say that such work as I have in my mind, work like the *opus Anglicum*, has succumbed far less to time than to the brutality of succeeding generations. These naturally held the work of their own times in greater esteem, and thought little of using daily, and thus destroying, or else cutting and gradually defacing, the magnificent work bequeathed to their churches and treasure-houses. One is inclined to speak with bitterness of the later Renaissance and the Rococo periods, which replaced, with their own pretence of splendour, with their gilded cords and false pearls, the soberer beauty of the spun gold and genuine labour of their mediæval predecessors. These men went to the altar with their gifts in a quiet spirit of sacrifice, that glad giving of human labour I mean, which finished the sculptured pillar, standing invisible in deepest shadow, and embroidered miniature angels on the orphreys of an altar covering, which no eyes but those of the priest—and his perhaps dim with age—could see in the twilight of a great church.

In my wanderings among old churches in England and abroad, I have always asked to see the most valued vestments in the treasury, and, time after time, I have been met in one of two ways; the custodian would shrug his shoulders and say, "There is nothing, all the old things are given away to poorer parishes," or else, which I assure you is far more irritating, he makes a great parade and flourish, and opening the cope-chests and wardrobes, displays with unction some glittering horror perpetrated in modern times. The Napoleonic vulgarity in the treasury of Notre Dame, of Paris, is scarcely to be surpassed, considering the heaped splendours that must have lain there, and nothing but the remembrance of the treasury of Troyes Cathedral soothes my irritation at it. And my recollection of the Troyes treasury is of the pleasantest, the little old sacristan, the most patient and smiling of men, kindly letting me admire undisturbed, though his duty compelled him to wait my pleasure before leaving the place. At Saint Ambrogio, in Milan, I was shown an altar decoration of handsome work, but was con-

siderably amused to learn from the lay-brother who took me round that it was used for their feasts of the second order, and was, as it were, one of the "second best" cloths, the "Sunday best" being unimportant enough to have since slipped my memory.

I need scarcely remind you that ecclesiastical embroidery in the Middle Ages was no holiday pastime of great ladies; that when undertaken by amateurs it was worked by them in as businesslike and thorough a manner as in the church schools or the lay guilds themselves. So that there is really no necessary division into professional and non-professional work, though it may vary in character according to school and place. In its design we find repeated the characteristics of the manuscripts of the period: crisp drawing, absolute sureness of hand, minuteness of detail that is surprising in materials whose pictorial possibilities are so limited. I touched on the two opposing characteristics of the Gothic spirit, an eager boldness and a fanciful inventiveness and imagination—characteristics we get in the finest *opus Anglicum*, which is the most important early embroidery of which I shall speak to-night. Here style, colour, execution are so balanced as to form a whole whose intellectual quality gives it its standing in the sacred ranks of what are called works of art. The boldness that attracts us is so interwoven with delicacy of detail, as in the portraiture of dress, and of architecture, in the drawing of animals, of birds' wings, foliage, and the like—that it is hard to say which of these is the predominant feature. When we examine the photographs that will be thrown on the screen presently, I shall ask you to note one thing which is very important. I mean the extreme freedom in drawing of plant-life, within, of course, the limitations of the art which his handicraft imposed on the mediæval artist. This effect of realism, however, is continually ignored by those to whom the mediæval spirit is antipathetic, or its leading points unstudied, though it literally hits them in the eye. You know it used to be thought witty—if not deeply critical—to speak of gaunt mediævalism, the stiff, ungraceful drawing of figures, the incomprehensible conventionality of the ornament, and the general want of expression of the faces, and so forth—all because the mediæval worker cared less to make his roses clumsy portraits a long way "after Nature" than to make them pleasant symbols of the flowers in his rose-garden, reverently disclaiming any possibility of producing anything one-tenth part so beautiful. This contempt of the serious art of a past generation, which might well have an historical interest for those to whom its intrinsic qualities did not appeal, is now altogether out of date, and I will not spend your time over it, feeling sure that the difference is clear in your minds between clumsy and unmeaning stiffness—the stiffness of a lifeless body—and the rigidity which springs from the energy of life itself. If I quote Ruskin's use of the word rigidity, it is because there is no other to explain the quality described by the master whose wonderful grasp of language has summed up for us the nature of Gothic for the first and last time. I feel sure, too, that you feel the difference between the "freedom" of a naturalistic drawing of a rose, or a photograph with its plausible completeness, and the "freedom" of a branch of rose or hawthorn fitted above a cathedral arch. The mason's intellectual effort in transposing his rose to the stone in fair order is worth more to us than dozens of branches "thrown"—that, I believe, is the proper expression—on a sheet of paper by a clever student, or miles of "effective" photography. This is not and never could be nature; that has properties, the enumeration of which would take us too far a-field to-night, but which we are accustomed to sum up roughly in the one word, Art.

The embroidery of the 14th century shows this same freedom and grace of drawing in animal and plant life, but its principal charm lies in the noble and expressive figures, with their still, large-eyed faces, their slender hands and feet, their crisp draperies, their haloes and jewelled crowns. For expression does not lie wholly in the face; and, indeed, in decorative work I should say it lies less in the face than anywhere else. It depends on the pose of the figures, the grouping and drawing of the folds of a gown, the placing of a wreath of flowers—anything, in short, that can be clearly expressed or symbolised with the needle. Thus in the early work we look for expressive grouping, that dramatic story-telling quality characteristic of the Middle Age, that quiet beauty of colour, and precision of detail in architecture and dress; so that a fine cope can be placed and dated by its style to within a few years, as easily as a manuscript of the same period. The most important copes and altar-pieces are usually covered with some scheme of design in which the figures of the saints and martyrs, of Jesus Christ, of the Blessed Virgin, &c., are drawn in little niches,

in cusped and pierced arches of singular beauty, or else they are placed in a net-work of quatrefoils, or circles interlacing, or of delicately drawn wreaths and boughs. Of such a nature is the Syon cope, which we shall presently examine, a very complete and well-preserved piece of work. It can be seen in the South Kensington Museum, though it is obliged to live in a twilight corner suitable to its delicate constitution and extreme age. For form's sake I will give its history, for you very likely know already what little there is to tell of so famous a piece of work. In 1414, this cope was given (probably by Robert Graunt, an ecclesiastical lawyer, to the religious house St. Bridget at Isleworth, built and endowed for the nuns of that order by Henry V. under the name of Syon-house. The date of the work itself is 1280, which leaves a gap one would like to fill in. Then at the beginning of Elizabeth's reign, the nuns had to leave their quiet home by the Thames, and,

FIG. I.

GROUP FROM REREDOS AT STEEPLE ASTON—"MARTYRDOM OF S. STEPHEN." (About 1280.

after a wandering life, finally settled in Portugal. It is only recently that this vestment found its way back to England and the South Kensington Museum, softened a little by time and the red ground faded, but all the other colours extraordinarily fresh. There is another cope of this period existing in England, though not so well known, of which I shall speak more in detail when we have the slides before us. The Christ and His Apostles are worked entirely in fine gold thread, in a net-work of wreaths of gold oak and ivy-leaves. It is guarded by careful hands in a quiet little village perched on a hill above the valley of the Cherwell, its wrappings undisturbed from month's end to month's end; a buried treasure, to whose existence in Steeple Aston and its first coming there one has no clue. On the technical side of the work of this time I shall have more to say when we have the pictures before us. It was invariably of great delicacy, worked sometimes

on a silk ground, sometimes on velvet; or, as in the Syon cope, the ground itself is of fine silk needlework. The plentiful use of gold also of extreme fineness is another leading feature; gold supple enough to be threaded in a small needle and passed like a silken thread, without breaking or spoiling.

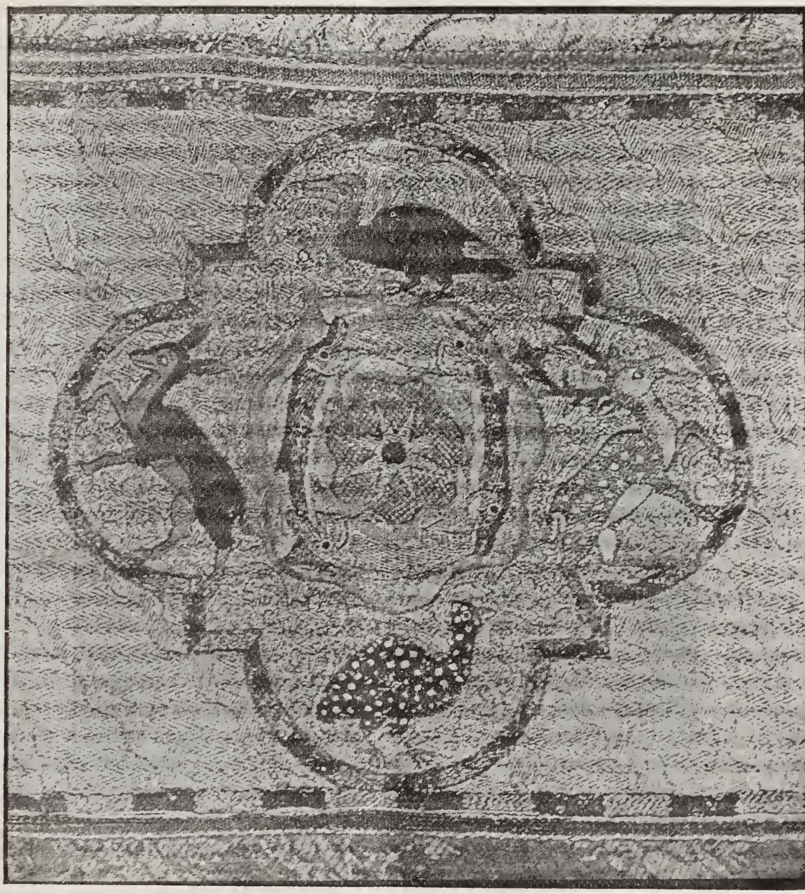
Before I turn to my notes on the technique of the early schools of embroidery, it may interest you to get a glimpse into the mediæval workshops and craft-guilds of the art, and the standing of those who followed it. In the thirteenth century certain rules were drawn up in Paris by the community of *maîtresses-ouvrières* for making those *aumonières* or *bourses sarrasinoises*, spoken of before. These rules ordained that no mistress should have more than one apprentice at a time, who must be bound for six years at least. She was not to use poor gold or mix her silk with any of an inferior quality, "because such work is false and bad," and for these and other dishonesties a defaulter was to be whipped. She must not employ "blacklegs," and neither mistress nor worker was to work on feast-days or village fair-days. The names of the community are given, some of them pretty enough to be noted:—"Peronelle des Jardins," "Marie la portresse," "Thomasse la Normande," "Jaquelline la crespinière," "Thyephaine de chiex la Royne," "Emeline la lombarde," "Lorente la Noire," "Marguerite la maçonne," "Peronnelle de Touraine," "Jehane la bele," "Jehanne flourie." The guild of *aumonières* was separate from that of the embroiderers. There was also a corporation of *chapelliers*, who made head-dresses embroidered with pearls and gold; many rules guarded their craft from dishonest work. The *crespiniers*, also, made many of the details of a lady's dress, embroidered gloves, ribbons and borders, and the like. In the statutes of the embroiderers and embroidresses of Paris I find also some charming names:—"Ysabelot, daughter of Lorenz the Englishman;" "Agnès, wife of Simon the parchment-maker;" "Julianne, wife of the late Nicolas the illuminator;" "Ermengart of Lombardy;" "Henry the embroiderer;" "Thevenot the little;" "Emeline, wife of Vincent the enamel-worker;" "James the embroiderer;" and "Colin, the embroiderer who lives with Madame Blanche." They were not to take apprentices for less than eight years, even with a premium. They were not to work by night—only as long as the daylight lasted—"for work done by night cannot be as good and sufficient as work done by day." Later on, in 1316, the embroiderers and their wives appeared before the Provost of Paris to issue some new rules, and among those present were "Margot the illuminator's wife," "Marguerite of the long locks," "Aaliz the mustard-maker's wife," and "Pernelle the gay." They order that no gold shall be used of a less quality than ten sols the stick and wound on good silk, and, if work is turned out of good materials but with stitches not sufficiently fine it shall also be considered as false, "for one may falsify just as much by making the stitches too large," they say, "as by using bad stuffs." We know that men of those days had a particular dislike for adulteration of goods. In 1423, Henry VI.'s "wise and worthi communes" are petitioned "for as mochell as in the citee of London and in the suburbes thereof, diverses persones occupying the craft of brauderie maken diverse werkes of brauderie of insuffisaunt stuff and unduly wrought." These people seem, dreading the searching eye of the wardens of embroidery in London, to have taken their inferior wares to the big country fairs at Stourbridge, Ely, Oxford, and Salisbury, dealing in them there "to the great deseit of our sovereign Lord the King and all his peple." The wardens were authorised to search the fairs for such goods, and, when found, to seize them. In Paris in 1292 there were fourteen *maitre-brodeurs* or *maitresse-broderesses*, and three years later ninety-three persons, masters, mistresses and workers, are noted as appearing before the Provost. The *chasubliers* again were a separate corporation, becoming the *brodeurs-chasubliers* in the 16th century, when everyone who wished to enter the guild had to submit an essay-piece, or *chef d'œuvre*, which was not to take over two months to finish.

The great dukes and kings and queens of France and England had sometimes numerous embroiderers attached to their service. Dendenell de Drek (I suspect the spelling of the scribe, for the name is too eccentric!), Richard II.'s cloth-of-gold worker, petitions for arrears of payment due to him. "The lady de Coucy, governess to the young Queen Isabel," he complains, "lives in greater splendour than the Queen. She has two or three goldsmiths, eight embroiderers, two or three furriers," and so forth. And Isabeau of Bavaria, one fine day, ordered a set of chapel-hangings and vestments of "Jehan de Clarcy, brodeur et varlet de chambre du Roy." She explains

minutely what she wants—the History of the Passion, set in squares, embroidered well and richly in stars of gold and rays of the sun; the edges and collars of the vestments to be set with seed pearls, and the diadems of the figures with big ones—as many as it pleased the Queen to have, for she provided them herself.

It is not possible, or indeed worth while, to trace out the individuality of mediæval embroiders, though here and there one comes across a notice of some family famed for their skill with the needle, or a King's "embroiderer and varlet," whose excellence above other artists was deemed worthy of notice by the chroniclers and scribes. Little Jehan de Saintré, in the romance, has a present made him by a Spanish lord, of a Turk and his wife and children, who were all great workers in gold thread and silk; which family Jehan dutifully handed over to the Queen, who made great joy of the present. Various names of famous embroiderers are mentioned in the 14th and 15th centuries with which I will not trouble you, as I have not been able yet to find for them any pretty anecdote or anything but the name, which says nothing to us. Mention is made of later Italian workers, such as one family of Udine, so famous for their skill in this craft that their name of Nanni becomes lost in the worthier one of Recamatori.

Fig. 2.



Quatrefoil from Orphreys of Frontal at Steeple Aston.

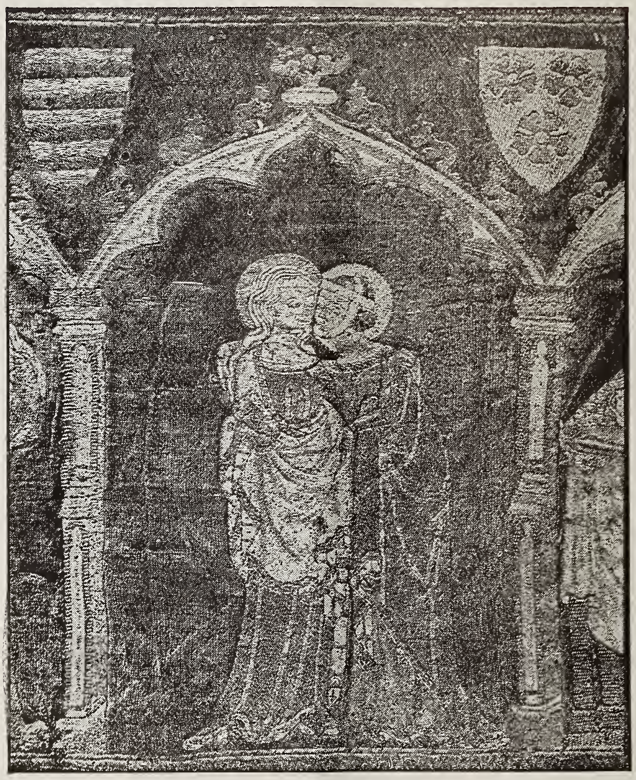
Having, as I hope, shown the important place occupied by embroidery among the arts of the Middle Ages, I will turn to the technical points of the different styles as a preparation to our illustrations. And, as a student of the practical as well as the æsthetic in this art, I

claim the right to make my own classification of method and style, and to put on one side any minute discussion on stitches, which are spoken off by the old writers with cheerful indefiniteness and variously described by modern writers. I prefer to divide the styles of embroidery as practised in the Middle Ages into two, or at most three, classes, of which we are principally concerned with the two first.

(*a*.) Embroidery in which the design is worked flat directly on a silk or velvet ground, or on a canvas ground filled in with the needle, or, if done on canvas and applied to the ground, it is applied very simply and with delicate and imperceptible edgings.

(*b*.) Work in which the design is done on a thick canvas, and then cut out and sewn on the silk or velvet ground with gold and silk cords and edgings. The work is often stuffed and modelled in relief, and finished with scrolls and flourishes; it is heightened with spangles, with pearls, and precious stones.

Fig. 3.



Group from Panels for Altar Frontal — "Life of the Virgin;" "The Meeting of Mary and Elizabeth." (Early 14th century.)

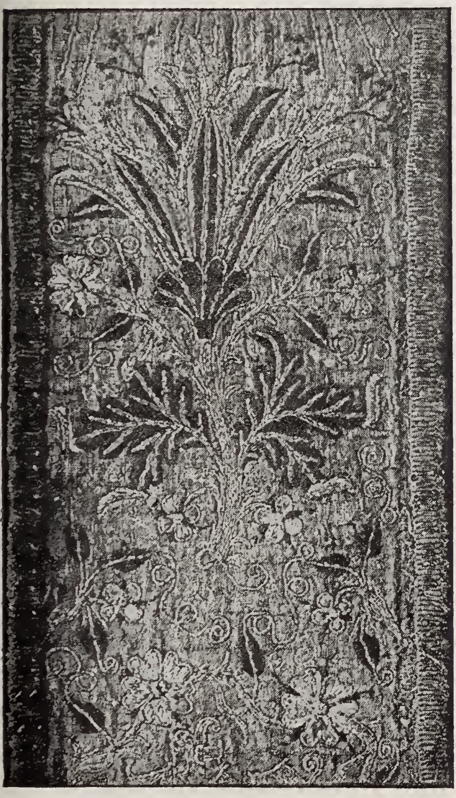
(*c*.) A third method would include all monochromatic work, such as white linen, or linen-work with faint colouring and outlining; such work depending on beauty of design for its effect.

The first style is represented historically by the work we call, and which we believe was generally called, *opus Anglicum*, forming a school famous throughout mediæval Europe, whose masterpieces were eagerly sought for. The second is generally called *appliqué*, or laid woik. These two methods overlap, of course, but the style is generally traceable, and the difference great in decorative quality. I will ask you to take it for granted until we can look at our illustrations and can compare for ourselves, that the *opus Anglicum*, the older work, is finer than the *appliqué*, with all its bold effectiveness. One might criticise the *opus Anglicum* for ever, but it remains the best, and approaches nearest to the standard of intrinsic beauty possible in a decorative

art; a beauty that persists through and under any modification of taste due to the temper of one age or another.

To return to the laid work and the later development of embroidery. In the first place, where the earlier work obtained its prestige by sheer straightforward toil of the hand (apart from its unique nobility of design), *appliqué*, in its different forms, lends itself to many little tricks and shifts for effect. This is no drawback in my eyes; everything is legitimate except wasted and vulgar labour. Pure *appliqué* is

Fig. 4.



Orphrey of a Chasuble. (15th century.)

extremely agreeable in its youth—restrained and delicate—but in its later years, its possibilities led those who employed it into mistakes, and, finally, into vulgarities culminating in the smartest French and Spanish vestments of the 18th century. No method of work is so well known or so widely spread as this. It is familiar even to the least inquiring male mind as "church-work." Unfortunately, modern ecclesiastical embroidery has a tradition crusted round it, to demolish which would do it a service. There was formerly no division between an ecclesiastical and secular style, except that, as said before, the best and richest gifts were offered to the church. The pictures of saints and heroes had a place round the hem of a great king's mantle, just as the chapel hanging might be set round with shields bearing the arms of the donor. But, with us, certain set forms are given as peculiar to "ecclesiastical design," which were used formerly, it is true, but which were merely the skeleton or scaffold of a design to be richly filled with every conceivable foliage and symbol. Such forms are now employed as the ornament itself, devoid of decorative detail. "Ecclesiastical embroidery" is similarly mistreated. I confess to being considerably shocked at the poverty of modern church work—more so, no doubt, than anyone to whom such work is familiar. Letters and ornaments, cut out of cardboard, and sewn over with a coarse yellow silk, cords and fringes of cheap gold, figures copied from photographs of pictures by obscure artists, and everything pretending to be just a little better than it is. If we are not rich enough in spirit and in goods to lay treasures at the foot of our altars without weighing the fine gold or counting the pearls on it, let us cover the altar tables with plain linen, stain the walls white, and confess a poverty that at least has nothing ignoble or vulgar in it. Such simplicity would be more seemly than the hurried offerings that fall so far short of the pure gold and myrrh and frankincense of true sacrifice.

The gold and silver *appliqué* that such orthodox church-work is taken from is late of its kind, and has a stiff and stately sort of richness that one associates with the Renaissance courts of France, and with the late Venetian pageantry. Such work, however, is quite unworthy of being copied, and if we are to study styles with a view to their adoption, a far more gracious form of *appliqué* is that English work of the 16th century, much of which is still scattered up and down England. The scheme of design is usually simple, and consists of angel groups and flower-de-luces, powdered over the surface of a damask or velvet ground at rhythmic intervals, with tracery and rays of light, stems and curves, worked upon the ground connecting the *appliqué* groups. Though these groups are rough in drawing, and have not the beauty and sweetness of earlier figure design, there is much spirit in them, and often a reminiscence of the earlier work in the way the angel wings fold over the body. Of course, you will under-

stand that many stitches can be included in this method of *appliqué*, of which I have sketched the merest outline. Where work in relief is intended, various ingenious plans of stuffing with cotton or linen are resorted to, and the gold or silk is laid or couched over this raised surface, and caught down with little stitches of varied colours, or with stitches of the same colour. Such work, heightened with pearls and polished stones, sometimes with gems and fine enamels, is closely allied to goldsmiths' work, and often mentioned with it in old inventories. A word about the treatment of gold, that most important of all the embroiderer's materials. Nothing is capable of greater beauty or of greater vulgarity. The best artists had a way of treating gold as one of the colours—the principal colour—of their palette; and, far from attemping to enhance its glitter, they subdued it by contrasted colour, or more often they broke the shine of it by the extreme fineness of the worked gold itself. If you call to mind some piece of smart modern work you have seen, it will strike you that what is aimed at in it is that the gold shall be as metallic as possible, and that the metal shall glitter and strike the eye. Mark the difference. The artist does not want to advertise his gold at so much an ounce, but to make the most of it as a material of decorative value. I don't say that the metallic man wants advertisement, either, consciously; but he is certainly determined that his work shall scream out "gold, gold, nothing but gold," with the brutality of a Kilmansegg. There is a dignity of reticence as well as the dignity of magnificence.

I have left till the last, mention of a method of gold-work, which is at its best in Italian 15th century work, and soon degenerated into sheer wasteful laboriousness. Imagine threads of gold stretched right across a ground, and then the design filled by minutest stitches across the gold of different coloured silks, through which the gold shines with varied intensity. It is impossible to describe it more distinctly without an illustration, but the effect is of arras tapestry-work, with golden warp threads. It is essentially a painting stitch; and it is not surprising that the Italian artists of the 15th and 16th centuries did not disdain to make designs for the craftsmen who could obtain such delicate shades of clear colour with their gold and silks. But the labour of such work is enormous, and for one beautiful and early example of it, we meet with dozens of debased examples, which make one wish it had never been invented. I am reminded by this of th only modern piece of writing on the art of em broidery that is pretty, and, at the same time shows practical knowledge of it. The heroin in Zola's "Rêve" is pictured as studying th Golden Legend in the house of her adopted parents, the *chasubliers* of the old cathedra town. Finally she takes to their art and i shown to us in a series of pretty pictures sitting over her frame and laying the gold o the bishop's vestment, working feverishly a last, when she is dying, worn out by passion and religious ecstasies. The whole is drawn with Zola's thoroughness, and, I may add, with Zola's idealisation.

It may strike you that I have left unmentioned several interesting methods o embroidery, such as the handsome Italian floss-work, couched on canvas, and other light and fanciful things I could mention. I have not spoken, either, of the rougher sorts o early mediæval embroidery, such as the piecing together of different coloured cloths or coloured linens, a curious example of which exists in the British Museum. But inasmuch as I set out with the object of describing the spirit in which the embroidery of the Middle Ages was worked, I am rather restricted in my area; and if I have included in our illustrations a good many examples taken from later times, it is partly because the date, as sometimes happens, has not affected the style of the work, and partly to mark the change from the mediæval temper to that of the Renaissance. It is not in my province to go into this interesting and complex comparison; the charm and dainty perfection of the early Renaissance work appeals to some people more than the boldness and wayward freedom of the mediæval. I can only set the two before you, and beg you, with me, to admire both.

I will ask you, finally, to note that the serious work of the 13th and 14th centuries, that I have put down as the best, is, in its execution, tranquil and undemonstrative—has, indeed, a touch of the arrogance of humility. It knows no royal road to perfection, except that of sheer industry; and, though no amount of niggling will of itself produce a work of art, this same dogged capacity for labour, with a sure eye and inventive brain behind it, at the time when these fragments oft wrought gold and silk were splendid in their freshness, produced all that is most worthy and most lasting in mediæval art. We find in this embroidery a character of repose and gravity; the faces are composed and thoughtful, the

draperies laid in long straight folds, while a certain loving and orderly luxuriance is allowed to all accessories of ornamental detail in flowering plant and woodland bush; the colour is massed with a sort of restraint, so that, in spite of the brilliancy of each hue, the general effect is not one of flashing splendour, but glows with a mysterious radiance that quickens the imagination and compels the eye to search closer. As a part of the documents by which our historians piece together the details of a past life that so vitally interests us, these fragments of needlework are invaluable, with their close detail of ornament, their vivid little bits of personality, their record of industry, piety, vanity, of passion sometimes and of sorrow. The Gothic gable that the townspeople watched as it rose gradually above the new cathedral, was recorded in golden threads on the borders of the priest's Easter gown, and the men and women that went in and out under the porch, dwarfed in the great monument their own steadfastness and love had raised, were painted on the church wall, woven into the chapel vestments —an added splendour to their costume, but still themselves in their habit as they lived. It was familiar objects their eyes lighted on, grown strange and rare, and woven into rhythmic ornament on the hangings that stretched from pillar to pillar, on the wreathed capitals themselves, and in the great windows whose dim jewels hung above the moving crowd: that crowd, which in the story of the saints and heroes they honoured, had written there, as in an open book, the lasting story of their own life, its efforts, and repose.

[The paper was illustrated by a series of lantern slides, and some fine specimens of mediæval embroidery, kindly lent by the Science and Art Department.]

DISCUSSION.

Mr. R. CATTERSON SMITH said the paper had been very interesting, and there was a great deal to be learnt from it. One point he should like to draw attention to was the naturalness of the work of these mediæval artists. It always struck him as a great mistake for people who thought they knew so much better to sneer at these things as if they were not based on nature and did not possess the natural qualities which we boasted a great knowledge of at the present day. It seemed to him that all this work bore evidence that people did not study nature, but they knew nature and therefore did not require to study it consciously. We, on the contrary, were so ignorant of nature that we were obliged to study it consciously, and the result was undoubtedly detrimental to art. It was not that we ought to know less of nature, but we ought to know it more fully and then there would be more time to study art. The great characteristic of these works was the presence of artistic knowledge and the control of nature. Nature being thoroughly digested and assimilated by an artistic temperament, the result was beautifully controlled work, never overstepping the modesty of nature.

Mr. R. STEELE said he had no claim to speak on this subject from the artistic side, but was very pleased to have the opportunity of drawing attention to the importance of this so-called minor art in mediæval life. The more one knew of the life of those days the more one found that this gracious decoration was not confined to the uses of the great and noble, or of the Church, but that it entered into the daily lives of everybody. There were not only the grander specimens of the art, such as had been shown, but there were simpler forms of it, which were associated with the life even of the poorest, in the shape of embroidery on very coarse canvas, simply showing a design in outline. It was, therefore, a form of art with which everyone was then familiar, and he felt that this great work was only possible because everybody knew something of the art, and could pass intelligent criticism upon it.

Mr. PHILIP NEWMAN said he was induced to come to hear this paper because he had been guilty of the crime which Miss Morris attributed to some of the moderns, of making embroideries for church work, and he must say, after what he had seen, that he regretted it. Having said this much, he must add his individual tribute not only to the very instructive paper, but to the charming way in which it had been delivered. He thought really the greatest compliment and the greatest justice they could render to Miss Morris was to say as little as possible.

The CHAIRMAN then proposed a cordial vote of thanks to Miss Morris for her very excellent paper. He had made a note or two on this subject. They had been prepared in view of the fact that the mediæval period was held to commence in the 6th century, and end in the 15th. Miss Morris had chosen for treatment the beautiful art of the latter part of that period only; and as his notes referred to the embroideries of the darker ages, from the 6th century to the 11th, he felt—looking to the rather late hour—they would be now somewhat out of place, as not dealing with that portion of the subject which had been so admirably put before them.

The vote of thanks having been carried unanimously,

Miss MORRIS, in reply, said she could not help regretting that the Chairman had not given them the

benefit of his studies on the embroidery of the period between the 6th and 13th centuries. She had felt that it would have been rather a wide field to cover. Not having very much time to spare, she had gone straight to the 13th and 14th centuries, when the work was at its very finest, and she must confess she did not care much for anything beyond the 15th century. The work seemed to stop there, and we had to begin afresh with our own methods, and, as far as possible, without copying.

FOREIGN & COLONIAL SECTION.

Tuesday, March 5, 1895; Sir EDWARD HILL, K.C.B., M.P., in the chair.

The paper read was "Colonies and Treaties," by SIR CHARLES M. KENNEDY, K.C.M.G., C.B.

The paper and discussion will be printed in the next number of the *Journal*.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 6, 1895; SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Aldis, Thomas Steadman, 37, Pembury-road, Clapton, N.E.
Burn, Robert G. L., 23 and 24, Charing-cross, S.W.
Chapman, John, The Lawn, Torquay.
Drew, Alexander, jun., Holme-lodge, Burnley, Lancashire.
Muddiman, Thomas, 35, Amhurst-park, N.

The following candidates were ballotted for and duly elected members of the Society.

Bemrose, Henry H., J.P., Lonsdale-hill, Derby.
Roberts, William, 13, Craven-hill-gardens, W.
Watson, Frederick Howard, M.A., 16, Kensington-road, Douglas, Isle of Man.

The CHAIRMAN said that before he called upon Mr. Radcliffe Cooke to read the paper of the evening it would be interesting, both to Mr. Radcliffe Cooke and his audience, to know what had before been done by the Society of Arts to promote the cultivation of apples and the production of cyder within the United Kingdom. He found that Mr. Thomas Skip Dyot Bucknall, of Hampton, was very active in communicating papers to the Society on "Orcharding," and in 1796, Mr. Bucknall received a gold medal for one of these papers [*see* "Transactions," vol. xiv. p. 207]. Like most enthusiasts, he was somewhat eccentric, as shown by his assumption, on being honoured with this gold medal, of the title of "Orchardist-General" for the United Kingdom. In a paper communicated to the Society in 1800, Mr. Bucknall proposed that cyder should be made an article of export to the West Indies [*see* "Transactions," vol. xviii. 304]. In 1802 he favoured the Society with a paper, entitled "Criterions, or due discriminations of cyder fruit," in which he writes:—"It has been observed that cyders were better 100 years ago than they are now. . . . When port wines became the luxury of the country, cyder, of course, naturally fell into disuse at the better tables" [*see* "Transactions," vol. xxi. 257-264]. In 1853, Mr. T. W. Booker, M.P. for Herefordshire, sent a communication to the *Journal* on "Cider and Perry Making." In it he writes:—"If the remarks which I have made shall awake due attention on the part of the cider and perry producers of our country, I feel convinced of this, that, to use the words of one who wrote on the subject 200 years ago—Dr. John Beal, F.R.S.—'those parts of England will be some hundreds of thousands of pounds sterling the better for it.'" And again:—"I have been asked by hundreds whether it is really the fact that during the visitation of that awful scourge, the cholera, which has again appeared among us, not a single case has ever yet occurred in Herefordshire. My reply has been *that it is so: I shall be glad to be corrected if I am wrong*" [*see Journal* vol. ii. p. 9]. There is no need for my introducing Mr. Radcliffe Cooke to his audience this evening. He is already well-known to you all as M.P. for the city of Hereford, and for the intelligent and energetic interest he has taken in the revival of the historical cyder industry of Herefordshire—the Pomerania of England, as Fuller quaintly designates it; indeed of all the cyder counties of the United Kingdom. Through his beneficent exertions, the National Association of Cyder Makers has now been organised, and it was in order to place the aims and objects of the Association prominently before the public, and on permanent record throughout the length and breadth of the Empire, that Mr. Radcliffe Cooke was invited by the Society of Arts to prepare his present paper on "Cider." On the conclusion of his paper, he [the Chairman] proposed to call on the leading cyder makers present to favour the meeting with their views on this most important agricultural question; and if there were any others present who might wish to take part in the discussion, he would be obliged by their sending up their cards to him, so that he might arrange for them all in due course having an opportunity of speaking. Having made these preliminary remarks, he now called on Mr. Radcliffe Cooke to read his paper.

The paper read was—

CIDER.

By C. W. RADCLIFFE COOKE, M.P.

Cider is the expressed and fermented juice of the apple: perry the expressed and fer-

mented juice of the pear. I should have thought it unnecessary to mention these elementary facts had I not discovered, even among persons who would be much nettled if they were not regarded as well-informed, a surprising degree of ignorance on the subject.

Some time ago, when dining at the House of Commons, I ordered a bottle of cider. When it was brought, my neighbour at table hazarded, with some appearance of doubt, the conjecture that cider was made of apples; while more lately a gentleman who, by-the-by, had often visited friends in Herefordshire, told me he knew what cider was made of, but not what perry was made of. I have found, also, a general impression that ciders and perries are all alike, and only to be distinguished from vinegar by a highly discriminating palate. This latter is not a correct view; though aware, as I am, of the acidity, sharpness, and thinness of much of the cider and perry made and consumed by the stout-stomached natives of the cider districts, I do not wonder that it prevails. Indeed, it is this ill-made stuff which, in a great degree, has discredited cider in general estimation.

It is not all apples nor all pears whose juice will make good cider and perry. Some modern manufacturers dispute this assertion, and even go so far as to say, as regards cider, that the best table apples make the best cider, and they therefore recommend that nothing but table fruit should be grown, so that when the larger and finer fruits have been disposed of for culinary and dessert purposes, the inferior grades may be utilised for cider. This is, I am told, the practice in the United States of America, whence a good deal of cider is shipped to this country. It is also followed in the Channel Islands. The experience, however, of all makers in the cider districts of England and France, where the industry has existed for centuries, points to a different conclusion, namely, that good cider and perry possessing the flavour, the quality, and the long-keeping properties which commend the liquor to cider drinkers, can only be made from special varieties of apples and pears, varieties for the most part too harsh and acrid for table use, and too small to be saleable for consumption. The presence of tannin in vintage fruit causes its unpalateableness for the table, and, at the same time, gives it its special fitness for the press. Mons. Hauchecorne, the author of a treatise on cider and cider-making, which gained the prize offered by L'Association Pomologique de l'Ouest, and the gold medal of the Central Society of Agriculture of the Seine Inferieure, says of this ingredient, "A few thousandth parts of tannin, or tannic acid, dissolved in liquors are sufficient to fix their flavour, moderate their stimulant action on the brain, and impart to them tonic properties. Tannin helps to clarify ciders, and lessening by coagulation the amount of fermentible substances, it prevents them from exciting in the juice certain disturbances which often result in the production of butyric acid."

The authors of that monumental work, the "Herefordshire Pomona," say that after sugar and alcohol (into which the bulk of the sugar is converted), tannin is the next most important element in the fresh juice. "It makes the liquor 'fine' more readily by causing the albumen, the pectine, and the yeast plants to be deposited, and thus acts indirectly as an antiseptic, regulates the fermentation, and prevents the after tendency to ropiness, so apt to appear in the liquor from fruits of great richness." The French chemists state that it requires from 2 to 3 parts of tannin in 1,000 in order to produce its full effect in the manufacture of cider and perry, and that from 2 to 3 more thousandths should be present in order to get the benefit of its wholesome qualities.

The best cider fruit, too, is with some exceptions below medium size. There is an advantage in this besides the quality that a measure of small fruit weighs heavier than the same measure of large fruit, and that standard trees will crop more profusely with small fruit than large, and not lose so much in windfalls.

This preference for small fruit over large for vintage purposes is shared by our neighbours across the Channel, who give expression to it in the common saying, "Petites pommes gros cidre."

Speaking generally of Herefordshire apples, with which alone I have a competent acquaintance, cider fruit may be divided into "Bittersweets," such as the so-called "Norman" apples and the "Wildings;" and "Red" fruits with a sharper and brisker flavour, such as the "Old Redstreak"—now almost extinct, and not so much valued as it was when Philips wrote his celebrated poem on cider, and placed it in the front rank—the "Foxwhelp," the most noted of all Herefordshire apples; the "Cowarne" and "Dymock Reds," &c. The "Bittersweets" are also, I am told, much grown in Somerset and Devon. They yield a rich luscious juice, and

give body to the liquor as well as colour, for it is singular that, although, as a rule, dull in complexion and with a flesh in many cases of a waxen whiteness, their juice is mostly highly coloured. The juice of the Red fruits is lighter and less luscious, but the cider produced is dryer, and, by some connoisseurs, preferred on that account to the cider made from the Bittersweets. Experienced cider-makers agree that the best cider is made from an admixture of the two sorts, the one giving colour and body, and the other briskness and flavour. It is usual to grind the two sorts together in the mill, but as they do not always become ripe at the same time, some prefer to make the cider from each sort separately, and blend them afterwards. The admixture of red sharp fruit with the "Bittersweet" has an effect also on the fermentation, which it is believed to help and quicken, so that cider made from mixed fruits becomes bright quicker than cider made from one sort only. It is, however, well in the case of apples of acknowledged excellence, such as the "Foxwhelp," the "Kingston Black," and some others which have a distinctive flavour, to make them separately, or, at any rate, to mix them with one sort only of an opposite character, and that the best of its kind. The tendency of late years in Herefordshire has been to plant more "Bittersweets" than "Red" fruits, partly because the "Bittersweets" are generally better bearers, and also because some of the best old sorts of "Red" fruit, such as the "Foxwhelp" and "Dymock Red," have not been propagated so continuously as they should have been, and are, therefore, becoming rarer year by year. I am told also that of late years there has arisen a demand for sharp brisk apples for jam-making, and that much fruit of this kind that used to be made into cider is now utilised for that purpose.

With regard to pears, although the varieties are much fewer than of apples, there is in the juice more difference in flavour between the sorts than there is between apples of sorts. Pear trees also are much longer lived than apple trees. It is rare to see an apple tree 100 years old, but pear trees twice and even thrice that age, and still in full bearing, are common enongh. They grow also to a much larger size than apple trees, and a pear tree 200 years of age has quite the appearance and dimension of a forest tree. Perry, as usually sold in bottle, is a sweeter and thinner liquor than cider, with from one to two per cent. less alcohol. But as pears contain a larger percentage of sugar than apples, if the fermentation of perry is allowed to continue until the saccharine matter is exhausted, the resulting liquor is stronger than cider.

The two most noted kinds of vintage pears in Herefordshire, Worcestershire, and Gloucestershire, are the Barland, or Bareland, which is believed to have had its origin in the parish of Bosbury, near Ledbury, and the "Taynton squash," a combination name connoting the village in Gloucestershire, where it is believed to have been raised, and the tendency of the fruit to become so mellow on the tree as to burst when it falls to the ground. The reputation of the "Taynton squash" perry is of old date. Robert Raikes, a Gloucestershire worthy, was commissioned to purchase a hogshead of this celebrated liquor for the private use of George III., and it was principally with "Taynton squash" perry, and "Redstreak" and "Styre" cider that John Kyrle, the "Man of Ross"—whose memory lives in the poetry of Pope—was accustomed to regale twelve of his neighbours every market day. It is commonly believed that this celebrated pear exists now only in a few very old specimens, from which it is doubtful if healthy grafts or buds could be procured. I heard, however, the other day, that some comparatively young trees of the sort are to be found near Ross. If this information be correct it may be possible to revive this splendid variety. The principal reason perhaps why good sorts of vintage fruit have been allowed to perish for want of grafting of young stocks with healthy scions, is that the attention of farmers was at the latter end of the last century and the beginning of this turned chiefly to corn growing to the neglect of the then less lucrative cider and perry industry. Another may perhaps be found in the doctrine taught by Mr. Andrew Knight, of Downton Castle, in Herefordshire, a gentleman who devoted himself to philanthropy and horticulture, which was to the effect that no sort of fruit lasted longer than the original tree which gave rise to it. That if, for instance, a pear tree might be assumed to live for 250 years, grafts of a particular variety inserted say fifty years after the first introduction of the sort would form trees which would only live 200 years; and so on in like proportion so that eventually every sort must die out and be replaced by new and different sorts. This theory has been shown by experience to be quite unsound, many varieties, such as the "Longland" pear, still subsisting in full vigour,

which Mr. Knight, nearly 100 years ago, declared to be too old to propagate. Still his writings were much studied in the early part of this century, especially in Herefordshire, and may have had some influence in preventing the grafting of long-established varieties notwithstanding their approved quality. Some perry, such as that made from the pear I just mentioned — the "Longland" — closely resembles cider in colour and taste and is often sold for it. In seasons such as that of last year, when apples are scarce and pears plentiful, a judicious blending of the two liquors by persons who know by experience which sorts to mix produces an excellent drink which could not, except perhaps by a very fine palate, be distinguished from cider.

You will now expect me, after having briefly discoursed of vintage apples and pears as known to a Herefordshire native with some acquaintance with parts of Gloucestershire and Worcestershire, to say something on the subject of the manufacture of cider and perry, the method, in short, of making these liquors. The mid-season fruits which ripen in October are generally reckoned to make better and more lasting cider than the early and late varieties. The fruit should be gathered when ripe, or nearly so, and placed in heaps not more than 12 inches in depth, either in the open air or under cover for a fortnight or so, according to the weather, to mellow. They should be kept from contact with the soil, and protected by some light covering, such as hurdles, with straw intertwined, from the rain; but otherwise, exposure to sun and air will help to mellow them, and prevent them from heating. Their perfume, and the blackness of their pips, will show when they are ready for the mill. The old-fashioned type of mill, still in general use in the cider districts, consists of a circular stone trough, in which a huge stone roller, like a grindstone, only much larger and wider, composed of a particularly hard stone from the Forest of Dean, called millstone grit, revolves by horse-power. The fruit is placed in the trough and ground to a pulp. The following is a description of the system pursued by an old cider maker in Herefordshire, lately dead, who used to turn out some of the best that the county produced. It was written for my information about two years ago, when I was engaged in preparing an article on the subject, which subsequently appeared in the *Daily Graphic*:—

"I exercise great care in selecting the best fruits, and, if mixed, know which suit best. When the fruit is mellow, I grind it, first removing all the decayed apples from among the sound fruit. I grind it in the old stone-mill, until the rind and core are ground up into a smooth pulp. You will see when it is sufficiently ground by taking some of the pulp in your hand, and pressing it a little, and noticing if the kernels and rind are well broken. When well ground, put the must out of the mill into a vat; let it remain in the vat 30 hours; then put it in the press and press out the juice, and put 100 gallons of the liquor into a clean vat; allow to remain in the vat until it clears; skim off any scum that comes to the top. It may take some days. When partially clear, rack it off into a clean vat, then add three pints of ground charcoal—not too fine—and let it remain for about 30 hours, and then pass it through bags carefully. Let it run through until it is clear, and when thoroughly bright, put it into a 100-gallon cask, and bung it down."

It is not necessary to describe at any length the press, which resembles an ordinary cheese press on a large scale. It consists of a framework, with a screw in the middle to give the pressure, and a large flat stone, grooved round the edge, or stout oak board at the bottom. On this, in Herefordshire, a cloth, made of horsehair, is placed, and a portion of the pulp put in the middle, and the edges of the cloth folded over it, and upon this another horsehair cloth is placed, and the process repeated until the cheese, as it is called, is raised to a sufficient height, when a stout wooden cover is placed on the top, and pressure by the screw applied gradually by means of levers. In Devon and Somerset they very generally use straw instead of horsehair, and, in the more modern presses now in use, Manilla cloths. You will observe that, in his system of cider-making given me by the Herefordshire cider-maker, he laid stress on the breaking of the kernels and the thorough crushing of the rind. With regard to the breaking of the kernels opinion differ, and most cider-makers of the present day agree with Mons. Berjot of Caen, who says that in making the best cider from the richest and most highly-flavoured fruit, it is better not to crush the kernels, because the scent of the essential oils contained in them masks or disguises the distinctive flavour of the fruit; but that in the case of fruit of second-class quality, it is well to crush the kernels in order that the deficiency in flavour of the apples may be supplemented by the flavour of the kernels.

It is not, however, so much either in the grinding and pressing of the pulp that difficulties arise as in the after-treatment of the

juice during fermentation. It is not my province here to discuss from a scientific point of view the theory of fermentation. It is now well known that fermentation is due to the ferment germs of the yeast plant, and there are, if I may speak as an amateur, bad and good ferment germs, and after the latter have set up the due amount of vinous fermentation necessary to convert a requisite quantity of the sugar contained in the liquid into alcohol, the bad ferment germs will often start a fermentation of a different character, which either turns the liquor practically to something very like vinegar, or renders it thick and ropy, a condition, which once established, destroys the quality and goodness of the liquor, although by artificial means, and the use of chemicals, it may be cleared of the matters in suspension, and rendered bright and even palateable. Speaking broadly, cider-makers suffer from two evils after the juice has been expressed from the press and vatted. Either in consequence of a cold wet season, a deficiency of sugar in the fruit, or other like causes, sufficiently active fermentation is not set up, or the fermentation is too persistent, and continues so long as ultimately to exhaust all the sugar in the cider, and render it hard and acid. The first evil—dilatory fermentation—is the lesser of the two, and may be overcome by heating the buildings in which the liquor is vatted, or by drawing off two or three gallons of the liquor, heating it to a temperature of about 70° Fahr., and returning it to the cask, stirring it in with a bundle of birch or osier twigs. Persistent fermentation is a more serious matter. When by the use of the saccharometer it is discovered that the density of the liquor has fallen below 1040, steps must at once be taken to moderate the fermentation. The old practice was to keep on racking the cider as often as it began to fret. This, so to speak, quieted the liquor, but, at the same time, the frequent repetition of the process weakened the cider, and deprived it of its quality and body. More recently, chemicals have been used to destroy the ferment germs. Most of these depend on the sulphur they contain. The efficacy of sulphur in checking fermentation has long been known in cider districts, where it has been a common practice to burn sulphur in the casks until the atmospheric air is exhausted and the cask filled with fumes of sulphurous acid gas. The fermenting liquor is then racked, preferably by a syphon, into the cask, without allowing the fumes to escape. The liquor absorbs the gas and the yeast plants are destroyed. The burning of sulphur in the cask has also the effect of destroying any putrid germs which might exist in the cask if not properly clean. Although, however, the liquor thus treated is said not to be injured in flavour when the operation is properly effected, some connoisseurs consider that it does to a certain extent destroy the delicate aroma of good cider. For cleansing casks it is now considered better to thoroughly moisten them inside with bi-sulphate of lime. But even if by all or any of these methods fermentation is checked, the liquor will often remain cloudy. This is owing to the mucilage contained in the richer sort of fruits, especially in pears. A little isinglass dissolved in some of the liquor and put into the cask, will generally have the effect of clearing it, but, as a rule, the richer ciders and perries have to be filtered in order to make them bright. This filtering has, until recently, been effected by running the liquor through bags made of a kind of linen stuff called forfar, like large jelly bags sewn on to a wooden hoop to keep the mouth open, and so cut that when four bags are hung in a frame their points will meet in the centre over the middle of the tub into which the clear cider that runs out of them is caught. Filtering through bags, if carefully conducted, is quite effectual in making the cider bright, but the process is a slow one, and the cider, to my thinking, loses some of its quality by long exposure to the air. It is also found that thorough filtration acts as a check on fermentation, probably by the extraction of many of the ferment germs, so that nothing so effectually stops the too rapid or tumultuous fermentation which often takes place in cider made from early fruits, or in hot weather, as filtering. The system of cider-making with the stone mills, though capable of turning out, if perfect cleanliness of casks and utensils be observed, cider of the highest quality, is too slow where a quantity of fruit has to be made into cider and perry in limited period; where in fact a large make of cider and perry is expected to be followed by a quick sale. There is also a great loss of time and waste of labour in the carriage of the bulk of the must and liquor by hand to and from the press, and in racking cans from vessel to vessel. Consequently moveable mills, in which the fruit placed in a hopper was first cut up by a spiked wooden roller and then crushed between stone rollers, have long been in existence, and I remember as a boy, in a year when there was

a great hit of fruit, one of these portable mills (turned by hand) coming to my father's farm and supplementing the work of the two old-fashioned stone mills in which the cider and perry were usually made. The modern mills now in use are all constructed after the fashion above described with such improvements as experience has suggested. Worked by steam power, as most of them are, they are capable of reducing to pulp a vast deal more fruit than could be dealt with even in the most capacious stone mill. Improvements have also been made in the presses, though the principle of construction of these latter machines is almost necessarily alike. It is, however, in the filtering of the juice that what may be termed the greatest innovations have been introduced or suggested. The best cider-makers in Herefordshire certainly, and in many other cider districts too, the men who have the reputation of producing cider and perry of the highest quality and therefore fetching the highest price, are all agreed that the pulp, or pomace as it is sometimes called, after crushing and reducing to the proper consistency, should not at once be put in the press and the juice extracted from it, but should be put into an open vat and allowed to remain there from 24 to 48 hours, or even longer according to the temperature. In this state fermentation at once commences and the lees begin to settle. The advantages of this practice are supposed to be that—as the authors of the "Herefordshire Pomona" state, "The juices of the fruit, set free by the crushing, are enabled to re-act on the peel, the kernels, and more solid tissues, aided, doubtless, by the alcoholic fermentation which so quickly sets in; and they thus have time to extract the full flavour, perfume, and colour of the fruit, which are all so essentially required to give character to the cider. The common practice (becoming, unfortunately, still more common) of pressing the pomace direct from the mill is therefore very disadvantageous." Also, when a considerable amount of fermentation is set up before pressing, it is alleged that the after fermentation of the expressed juice is of a more moderate and equable character than is the case with juice expressed trom the pulp directly it is taken out of the mill.

More modern practitioners—whose main object appears to be to hasten the processes of nature, in order to obtain as quickly as possible a quantity of liquid which they can handle free from the difficulties caused by fermentation—recommend not only that the pulp should be pressed as it comes from the mill, but that the juice, as it runs from the press, should forthwith be filtered. Apart from the reduction in the quality of the cider, which, in my judgment, would be brought about by this process, there are insuperable mechanical obstacles in the way. There is no filtering substance known to me through which fresh apple juice, as it runs from the mill, could be forced through clear, except in very small quantities—as a few gallons—without clogging the filter. The process has been tried with one of the most effective filters in the market, with the result that no more than a nine gallon cask full of clear juice could be obtained; and of this very juice I may say that bright as it was when bottled, it all went cloudy after a few days. Nor is this surprising when we consider the great amount of matter held in suspension in freshly expressed apple juice, and see how much of this matter, under a natural fermentation, rises to the top of the liquid, and how much sinks to the bottom. If the right moment be caught in a favourable season, when the liquor has dropped bright between the two lees, as the French say, and the clear liquor is racked off undisturbed into a clean cask, you have cider and perry in the highest state of perfection, as clear as crystal, with all the flavour and richness of the fruit preserved in the highest degree. It is also to be observed that the juice of the fruit differs in its action, according to the variety. Some perries will run clear through the bags or filtering appliances, whilst others, as the juice of the "Huff-Cap" pear—a much esteemed sort—are extremely difficult to strain. The conclusion, therefore, that I draw is that in all cases natural fermentation should precede filtration, but that after this primary fermentation has practically ceased, or it is found, by testing the liquor with the saccharometer, that the density has fallen below a certain point (say 1,040) then filtration, in order to render the liquor fine, or to stop the fermentation instead of racking, may be used with excellent effect. There are many ways of filtering cider besides that already described of running the liquor through bags. One firm of American cider manufacturers are said to filter their liquor through mica sand, a bed of which material is found handy to their works. It does not appear however, from what I can gather, that this practice has been to any extent adopted in England, or where it has been tried, has been markedly successful. The most effective filter

that has been brought under my notice is an ingenious machine in which the liquor to be fined is forced by a pump through discs of compressed cotton and delivered bright into the receiving cask. This process is rapid in its operation, and is likely, in my judgment, to prove a great assistance to cider-makers.

Having now dealt, necessarily with brevity, on the process of cider-making, I must say a few words on the past and present condition of the industry and its future prospects. In the 17th century, owing partly to the patriotic efforts of Lord Scudamore, of Holm Lacy, near Hereford, who is said to have introduced several new sorts of vintage fruit from abroad, and in various other ways to have stimulated the cider trade, cider and perry making became profitable industries, and attention was paid to the condition of the orchards, and the cultivation of the best sorts of apples and pears. Dr. Beale, a noted horticulturist of his day, writing from Hereford in the middle of the 17th century, speaks of Herefordshire orchards as "a pattern for all England." Would that the same could be said now. The result was such as might be anticipated. A brisk trade sprang up in these liquors, and high prices were obtained. About a hundred years ago, an Irish gentleman, who desired to better the distressful condition of his native land by more sensible and businesslike means than those which now approve themselves to some of our legislators, conceived the notion of improving the state of the fruit orchards, and consequently came to England and made a tour through the cider districts, with the object of learning all he could on the subject. In his travels he reached Herefordshire, and, staying for a while at the town of Ross, reports that at that date good cider fetched 10 guineas a hogshead (Herefordshire hogsheads probably held then, as they do now, from 100 to 110 gallons), and that in the neighbourhood of Ross one farmer sold, of his own making, 50 hogsheads, all at that price. In the present day our farmers would be glad to get half that price, and would then find cider-making more profitable than corn-growing. This gentleman also mentions that he was entertained by John Kyrle, and in the parlour of that worthy was regaled with "Taynton Squash" perry, which he pronounced equal to the best champagne. Even so lately as 60 or 70 years ago, cider was sold by Herefordshire farmers straight from the mill at one shilling a gallon. Last season they got 2d. or 2½d. a gallon for new cider, inferior, I do not doubt to that just mentioned, but yet given away at the price. When, however, farmers turned their attention almost exclusively to corn-growing and cattle-raising, cider making fell into the background: the orchards were neglected; the good sorts were not propagated by grafting—mere wildings often took their place, or inferior sorts, preferred not because they made good cider, but because they were free-bearers, and helped to fill the vessels in a scarce year. Another reason, too, for the decay of the industry is to be found in the selfish and suicidal conduct of the cider merchants or middlemen, who, after buying the cider from the farmers—often at an exceedingly low price—thinned it with water, making, as the saying went, five hogsheads out of three, and then doctored and fortified it in order to disguise their malpractices, and make stuff sufficiently palatable to sell in Bristol and London, which were the chief centres of the trade. The result of the spreading abroad of this thin, doctored stuff for pure cider was to bring the drink into general discredit with the public, and ultimately to lessen the demand for it, and injure the trade. Moreover, farmers, not having the incentive of a brisk demand and good prices, not unnaturally neglected the industry, and became careless, not only in regard to keeping their orchards in a good state, by pruning, dressing, and renovation, but also in regard to the making of cider and perry. Sufficient attention was not paid to cleanliness of casks and utensils; to the selection of suitable fruits for grinding together; to the removal of all decayed and unripe fruit before crushing in the mill, and to the fermentation of the juice afterwards. The result was the production of inferior, thin, and acid liquors, which, retailed in the public-houses, gave visitors to cider districts the impression that cider and perry were drinks akin to vinegar, which even the thirstiest soul in the hottest weather could only swallow under compulsion.'

Within the last few years, however, far-seeing cider-makers have been endeavouring to bring about a change in this state of affairs, and there are now makers in the cider districts who by care and attention to the business and the adoption of modern appliances and scientific methods are effecting a revolution in the trade. My object and the object of those who have been good enough to help me in forming the National Association of Cidermakers, is to supplement the efforts of these gentlemen, and to endeavour to revive what once was and what

in my judgment will become again a flourishing home industry. In these days of depression in agriculture, when farmers are everywhere complaining of low prices consequent in the main on foreign competition, no industry ought to be neglected which offers a promise of profit however small it may seem to be. But cider-making, although practically limited to the West of England and the west Midlands, owing chiefly to the quality of the soil of those regions and the climate, is by no means a small industry. Although there are no statistics which show the annual out-put of cider and perry some notion may be gained of the importance of the industry from the extent of the orchards most of which are devoted to vintage fruit.

According to the last returns the acreage under orcharding of the five principal cider counties is as follows:—Devon, 26,725; Hereford, 26,435; Somerset, 24,186; Worcester, 19,322; Gloucester, 17,946; making a total of 114,614 acres, or more than half the entire area under orcharding in Great Britain. These figures, as regards the cider counties, are below rather than above the mark for this reason, that there are everywhere in the fields in single specimens or dotted about in clumps pear and apple trees, the pear trees often of great size, the remains of orchards which have been cut down in order that the ground might be put under crops. These, which taken together would add largely to the figures, are left out of account in the above classification. I have said that there are no statistics to show what the out-put of liquors from these orchards is, but you may judge that it is enormous when I tell you that the crop from a big pear tree, in a good season, will yield as much as 200 gallons of perry, and there are instances on record of this yield being trebled. Now, notwithstanding that our orchards have been neglected, and that they contain a proportion of worthless fruit, they are still capable, in their present condition, of giving an enormous yield of good liquor. The industry, therefore, is one of considerable importance, and, as such, worth developing. Moreover, there is this further to be said for it, that it is a home industry which, in respect of the better descriptions of perry and cider, has nothing to fear from that bane of English agriculture—foreign competition. You will ask me to justify this proposition when you know, or when I tell you that, in 1893, 558,108 gallons of foreign cider were imported into this country, of which quantity no less than 537,174 gallons came from the United States of America, and that in all probability the importation from the same quarter was larger still in 1894. But this American cider is, in my judgment, quite different from good English cider, and vastly inferior. It is, as I have said, made from the poorer grades of culinary and dessert fruits which cannot be disposed of in any other way. In order to bear the voyage it has to be Pasteurised, that is, heated up to a certain temperature, generally 160° Fahr., a process which destroys all the germs of fermentation, and renders the liquid flat and dead. This killing of the ferment germs takes place when only a small part of the sugar has been converted into alcohol, so that the liquor, as it comes to this country, is sweet and of low alcoholic strength, and has to be artificially carbonated in order to give life to it. Now, the defects of this cider are, that made originally from fruit wanting in the ingredients essential, as I have shown, to the production of good cider, it lacks the character and quality of that liquor. Moreover, besides being made from non-vintage fruit, it is not made even from the best specimens of that fruit, but from the worst, namely, the undersized, unripe, and malformed apples, the best being previously selected for sale for eating purposes; and that the processes to which it is subjected before and after it reaches this country take, as we term it in Herefordshire, the nature out of it, and so deprive it of what little character it ever possessed. It is, I admit, for those who who do not know what really good cider is, a not unpleasant, sweet, and acidulated drink in hot weather, but it does not, in my judgment, possess the wholesome qualities of good English cider. An analysis of American cider, made some time back at the Royal Agricultural College, Cirencester, showed that it contained a large amount of sugary matter, only 2·25 per cent. of alcohol, and some salicylic acid added as a preservative, a chemical which, I am told, has a deleterious effect on the human body. The gentleman who made the analysis, and compared the American with several specimens of English cider, declared the former to be "a very different drink from good English cider," and in a letter to me he says, "Personally I think American cider a poor beverage — not nearly so wholesome and digestible as English. Good English cider appears to me a very wholesome drink." There is another consideration — I might almost say, danger—to be taken in account

with regard to sweet stuff of this kind. It could, I believe, be easily imitated by a concoction which should not contain a single drop of cider. With water, sugar, or glucose, tartaric or some other suitable acid, some colouring matter, and a so-called fruit essence, a drink could be compounded which would be equally palatable, but, perhaps, not quite so harmless.

Provide a regular and uniform supply of English-made cider and perry from vintage fruit of average quality, undoctored and unwatered, and there ought to be no difficulty in driving American or its imitation out of the market. Then the English grower of vintage fruit should, I think, pay special attention to producing liquors of fine quality, because in these he is without a rival. American cider, such as it is, does not pretend to be anything more than a sweet drink of no special merit. French ciders, of which about 20,000 gallons were imported into this country in 1893, are weak and washy in comparison with ours, while the only German cider in bulk which I have tasted in England was scarcely fit to drink. Some bottled German cider, or apple wine as it was called, which was given to me last year, had no resemblance to cider, but had a certain likeness to cheap Moselle, fortified with potato spirit or some similar ingredient. The general public are apt to compare cider with beer, whereas it should rather be compared with the light wines of France. Draught cider of fair quality, well made and sound, would answer to "vin ordinaire," while the superior brands made from fruits of special excellence, of which there is such an abundance in our orchards, would be likened to Leoville and Chateau Lafitte. This being so, the next question to ask is, would there be a sale for ciders and perries of these qualities? I think so. There is a larger demand now than is generally supposed. This autumn, being for a while at Buxton, I made inquiries about cider, not expecting to find that there was any sale for the liquor there—I was mistaken. I was told by a publican in the town that in the summer time he always had a cask of cider on draught, and sold quite as much of it as of beer to the working-classes; whilst a wine merchant, who supplied me with precisely the same cider, only in bottle, imparted to me the gratifying fact that in 1893, that very hot year, he ran out of English cider, and, unable to procure more of the same kind from the same firm, he bought a quantity of American cider, with the result that at the end of the season he had something like 40 dozen left on his hands, because his customers used to English cider would not touch American after it. Then my own experience, such as it is, testifies in the same direction. Last year I wrote a letter on the subject of cider and perry to the *Times* newspaper, and forthwith and intermittently, from that time to this, I have been applied to by correspondents from all quarters to tell them where they could get this excellent drink. I say excellent drink advisedly, for that cider (including perry) is not merely a pleasant but also a wholesome drink, is indicated in many ways. Regular consumers of cider are, as I say in the letter just mentioned, exempt from many distressing maladies. For example, they are not subject to stone or gravel.

William Hutton, the historian of Birmingham, related, as was told me by a descendant now living, that walking once through Herefordshire he stopped at a roadside inn for refreshment. Getting into conversation with some of the country folks he incidentally remarked that he suffered from gravel, whereupon one of his hearers replied, "You should drink our cider and perry, sir; we do not know what such complaints are in our county." Hutton took the advice thus given and was never troubled in that way afterwards. We enjoy in Herefordshire, and I believe the same may be said of cider districts generally, a remarkable immunity from disorders of a choleraic nature, and it is within the experience of regular cider and perry drinkers that contrary to the notion commonly entertained by outsiders gout and rheumatism fly before those liquors. This effect is now being appreciated by the medical profession. A gentleman who went last year to Baden in Switzerland to be cured of rheumatism wrote me word that the doctors there were recommending cider for that complaint, and very poor stuff it was, he added, compared with English cider. Another correspondent informs me that medical men in Paris are prescribing cider for gout, and instances a case known to him of a friend who three years ago was laid up with gout there for some months. He was ordered cider and has not yet had another attack. One of the highest medical authorities, as I am informed, on gout in this metropolis is now experimenting at my request with cider and perry with which I have supplied him. He has not completed his researches, but in an interim report which he sent me a day or two ago he says that the

juice of apples soon after it is taken in the form of cider (he has not yet tried perry) causes a slight temporary rise of acidity but has little or no effect on the acidity of the whole day, and he believes this to be due to the fact that apples contain not only an acid juice but also a large amount of potash and soda, and that in the process of digestion and absorption the salts formed by malic or other organic acids with these alkaline bases are converted into carbonates, and then act as alkalies. Hence, the rise of acidity produced by the fruit acid is very transient, as the alkalies, so to speak, soon overtake and neutralise the acids. Speaking generally, he adds, "The greater the effect on the acidity of the urine, the more likely is any beverage to produce or precipitate gout;" and he should expect therefore that cider (dose for dose) would be less likely to produce gout than either beer or wine. So much for the medical aspect of cider.

Whether, in these days of over-pressure, and consequent worry and anxiety, long life is a blessing, would, I imagine, be with many an open question; but, taking the old-fashioned and once popular view of the matter, it may not be out of place here to mention that the longevity of the peasantry in the cider-drinking counties has been remarked on by many observers. Towards the close of the 17th century the then vicar of Dilwyn, a parish in Herefordshire, took note of the ages of his parishioners, and their diet and mode of life, and has left an interesting record of the great age attained by many, both men and women, with all of whom cider was their daily drink. This peculiarity of the natives of my own county was confirmed in a quite undesigned manner in a conversation I had lately with Mr. Joseph Arch, the representative of the agricultural labourers in the House of Commons. Joseph Arch is a Warwickshire peasant, who, in early manhood, was the champion hedger of England. Some twenty-five or thirty years ago he was, if I may use the expression, imported by some landed proprietors into Herefordshire in order to teach his art to the labourers on their estates. While residing in that county he used, he told me, on Sundays and spare days, to visit the churches and churchyards about the neighbourhood where he might be, and what struck him most, he said, were the extraordinary ages recorded on the tombstones. Neither he nor I had touched on the subject of cider, so his testimony to the longevity of the inhabitants of this cider-drinking county was quite spontaneous. The time at my disposal has only enabled me to deal with the subject of my address in general terms, and, as it were, in outline. Inquirers will find much further information in a paper written by Mr. Chapman, late of Hereford, in the "Journal of the Royal Agricultural Society" for April, 1888; in the introduction to the "Herefordshire Pomona;" and, on the chemistry of the subject, in a paper by Mr. Lloyd, in the "Journal of the Bath and West of England Society" for 1894.

DISCUSSION.

The CHAIRMAN, in opening the discussion, said that considering the exhaustive manner in which Mr. Radcliffe Cooke had, in his admirable paper, treated the technical and economic aspects of the cyder industry of the United Kingdom, and that the meeting would be further addressed on these heads by several cyder makers present, his own remarks would be of the nature of a light interlude, dealing with points of general interest connected with the not less fascinating than important subject of Mr. Radcliffe Cooke's most practical and invaluable paper. In the first place, he did protest against Mr. Radcliffe Cooke spelling cyder with an "i"—cider. They all did it—the *Times*, which had done so much in promoting the beneficent movement headed by Mr. Radcliffe Cooke, and had always treated him (the Chairman) with exceptional consideration, persisted in doing it, and nearly all the cydermakers in the country did it. But there was no manner of excuse for it, and spelling the word with an "i" really took the best part of the savour and the goodness out of cyder. The pedigree of the English form of the word is usually traced from the Hebrew *shekar*, through the Greek *sîkera*, the Latin "sicera," and the French *cidre* to cider. And this is correct enough. But, like so many other ancient words in the English language, cyder has a complex etymology, and originates in the Latin "sisera," and Spanish "sidra," and Italian *cedra*, as well as in the French *cidre*. In Chaucer's "Monk's Tale" (*Canterbury Tales*), line 65, we read, in the Aldine Edition—

> "This Sampson neyther siser dronk ne wyn."

Some of the MS. give the word as sythir, and again as cyder. About one hundred years later, Hertzog's *Catholicon* (Venice, 1497) defines "sicera," from the Hebrew *shekar*, as a wine made from fermented grain, or apples. Adrianus Junius, in his Nomenclator, published in London, 1585, says "sicera is a Hebrew word, signifying a strong drink, which, according to Pliny, is made from apples." I cannot verify this statement, or find that Pliny anywhere uses the word "sicera," although in B. xv. ch. 15,

he tells us that wine is made from apples. Florio (1598) has "*cedra*, a drink from apples called cyder;" Minsheu (1599), "*sidra*, sider;" Gerard, in his Herbal, 1633, writes "syder;" Skinner (1671) has "sider, *see* cider," but has no entry under cider or cyder; and lastly Phillips, not the poet of cyder, but the lexicographer (1706), has "cider, an excellent drink made of apples," and, again, "sider, a known drink made of apples bruis'd and pres'd." These citations clearly prove that the word cyder, syder, or cider comes to us, not only through the French *cidre*, but direct from the Latin "sicera," and that the Latin form of it is older than the French. But for all makers and drinkers of cyder, and for all literary men, Philips, the poet (1676-1708), for ever fixed the correct English form of the word as cyder. He never, as a boy in Devonshire, knew it in any other form, and he did beg that in future they would, in the language of Mr. Weller, all spell it with a "y." It is interesting to record for handy reference early notices of cyder making in this country. What Evelyn (1620-1706) says on the subject is too well known to be more than alluded to. Gerard, who wrote before Evelyn, in his "Herbal" (1633), writes:—"Kent doth abound with apples of all sorts. But I have seen in the pastures and hedgerows about the grounds of a worshipful gentleman, dwelling two miles from Hereford, called Master Roger Bodnome, so many [apple] trees of all sorts that the servants drink for the most part no other drink but that which is made of apples. The quantity is such that, by the report of the gentleman himself, the parson hath for his tithe many hogsheads of cyder." He goes on to urge—"Therefore, forward in the name of God, graffe, set, plant, and nourish up [apple] trees in every corner of your grounds; the labour is small, the cost is nothing, the commoditie is great—yourselves shall have plenty, and the poore shall have somewhat in time of want to relieve their necessitie, and God shall reward your good mindes and diligence." Your Association could not take better marching orders. Next Moses Cook, "gardiner to the Earl of Essex at Cashioberry," in his *Manner of Raising, ordering, and Improving Forest Trees*, London, 1724, gives detailed directions "for making cyder," pp. 267-73. He says 18 to 20 bushels of apples should make a hogshead of cyder; that for cyder making "Red Streaks" and "Gennet Moules" are counted the best apples; but "the 'Golden Pippin' makes excellent cyder, the 'Russet Harvey,' 'Kentish Codlin,' &c., makes good; and, indeed, any apple that is not a Crab.' He quotes not only Evelyn, but Sir Paul Neal as authorities on cyder making; and adds, that Captain Wingate, near Welling, "hath an excellent Pear for Perry," and that "there is a Pear, called by my ingenious friend, Mr. Pritchet, gardiner to my Lord of Salisbury, Rufins Pear, which makes an excellent Perry.'' Finally, in E. Smith's "Compleat Housewife, or Gentlewoman's Companion," London, 1742, I find, under the heading "all sorts of made wines," a receipt at page 228 for making "Cider." The apples used "must be 'Pippins, 'Pearmains,' or 'Harveys' (if you mix winter and summer fruit together it is never good)" . . . . "Put two or three pounds of raisins into a hogshead, and two pounds of sugar, it will work better" . . . . "and bottle it in March." Gerard, in writing of the virtues of apples, and cyder, after stating that pomatum derives its name from having been originally made from apples, goes on to laud their curative effects in gravel, strangury, and other renal and vesical diseases. But the old folk-lore, alike of the Aryan and Semitic races, bears overwhelming testimony to the wonderful physiological and therapeutic powers of the apple. In the Scandinavian mythology it confers perennial youth. In Eastern Russia, women go out and sit under apple trees to obtain children, and the old practice of a young man planting an apple bough on May Day before the house of his betrothed, is another illustration of the primæval Aryan belief in the supernatural virtues of the apple. Again, in the "Arabian Nights," we read not only of the apple with which Rose in Bloom attracted the attention of Ansan Wajoud, but of the three apples obtained from the garden of the Caliph at Balsora, to cure a young wife from the fever of which she was dying, and in the story of the Fairy Banu and Prince Ahmed, of the apple obtained from Samarkand by Prince Ahmed, which was curative of all fevers, lung affections, and cholera, and a prophylactic against every disease, and with which he at once restored his fair cousin, Nurunnahar, from the point of death to renewed health, and perpetual youth and beauty. There can be no doubt of the great importance in the present agricultural condition of this country of the movement initiated by Mr. Radcliffe Cooke, and that in the shrinkage of the cultivation of wheat, an immense opportunity is offered to farmers for the revival, with the extension of pasture lands, of the cultivation of apples, and the manufacture of cyder and perry. In this connection, knowing how much was to be effected in all such efforts by arousing popular sentiment on their side, he had already urged on them to revive all the folklore that once flourished throughout this country in connection with their picturesque and romantic industry: and now he would venture to suggest that the Association should at once enter into negotiations for the publication of a new edition of John Philips's poem, "Cyder." It should be illustrated by Hugh Thompson. Philips describes with accuracy and enthusiasm the whole process of cider-making, and most of the old localities of the manufacture; and these should all be depicted by Mr. Hugh Thompson from studies on the spot. If possible the book should be ready by next Christmas. There should not be a trace of advertising in it, and if this restriction is religiously respected the publication would, he was sure, give a great fillip to the growing thirst for our national wine cyder. As he began with a protest so

would conclude with one, and that was against a [ten]dency of some of the friends of cyder advocating [its] claims to consideration on the ground of its being [t]eetotal drink. It happens to be a wine which a [te]etotaller may drink, for it contains a far less per[ce]ntage of alcohol than some of the authorised tee[to]tal drinks. He, indeed, had never known anyone [ge]tting drunk from cyder excepting the three young [ch]ildren, whose incessant declination into factitious [si]ns are the lugubrious theme of Mrs. Sherwood's [pu]erile novel, with an evangelical purpose, the "Fair[ch]ild Family." But it did not become sane men to [ur]ge a point in favour of cyder simply to secure the [su]ffrages of ignorant and fanatical faddists. Read [al]l the best literature of the world, inspired by [th]e highest human wisdom, the criterion of which [w]isdom is good will toward man, and what you find, [al]ike throughout the Bible, and in the literature of [G]reece and Rome, and of modern Europe, is at once [th]e strongest detestation of drunkenness and intem[pe]rance and the heartiest praise of wine—"wine [w]hich cheereth God and man," "wine that maketh [gl]ad the heart of man," wine to be given "unto [th]ose that be of heavy hearts," wine to be taken "for [th]y stomach's sake and thine oft infirmities;" wine [el]sewhere described in the same Hebrew scriptures [as] "the poison of dragons and the cruel venom of [as]ps. Again, Homer tells us (Iliad vi., 261) "that wine is strength to a wearied man;" (xiv., 13) [th]at "Semele brought forth Dionysus, causing great [jo]y to mortals;" and also that (Iliad vi., 265) "wine [lo]osens the limbs and deprives (a man) of his prowess [an]d wonted strength;" and (Odyssey xiv., 319) leads to folly, making even the wise to laugh and [ta]lk inordinately when they had better have kept [si]lence. But it is by Plato that the last word was [sa]id on the use and abuse of wine and other [al]coholic stimulants. It is a long passage in his "Laws," which he would only summarise here:—"Youth should altogether abstain from wine, for [it] but adds fire to their natural fire . . . . . but [b]etween 18 and 30 it may occasionally be taken to [p]romote conviviality . . . . . and from 40 men may [d]rink it freely, and thank Dionysus for his glorious [g]ift, for wine is a soveran remedy against the morose[n]ess of old age, for it makes the heart grow young [a]gain, aud keeps the soul soft that time tends to [h]arden, just as fire makes iron soft and handier to [h]uman uses." The truth is our national excess is [ra]ther in eating than in drinking, and it is only [b]ecause drunkenness is more dramatic in its effects [t]han gluttony that we do not recognise the fact. [N]ever was a more beautiful picture of true temper[a]nces in diet drawn than in Herrick's "Thanks[g]iving to God for his house":—

"Lord, I confess that when I dine,
The Pulse is Thine,
And all those other bits that be
There placed by Thee;
The Worts, the Purslain, and the mess
Of Water-Cress,
Which of thy kindness Thou hast sent.
And my content
Makes these, and my beloved Beet,
To be more sweet.
And thou tis't crown'st my glittering Hearth
With guiltless Mirth,
And giv'st me Wassail Bowls to drink—
Spiced to the brink!"

Such was the healthy regimen, and such the hearty piety of the men who defeated the Armada, and while struggling against the tyranny of the Stewarts at home, colonised Ulster, settled Virginia, and laid deep the enduring foundations of the Indian Empire.

Mr. F. J. LLOYD said he could not say much, as he had already published a paper, in the *Journal* of the Bath and West of England Society, on the chemistry of cider, and had another one in print, which would appear in a few weeks. He had taken great interest in this subject, and the general conclusion to which he had come was that the industry was of enormous importance to the farmers and landlords of this country, as well as to the consumers, but it was one upon which most people were painfully ignorant. There was no subject on which technical education was more required than cider making. There were a few cider makers who understood something of the science which underlay the process, but the vast majority of those who made cider did not in the least understand the chemical changes which took place, and until they could be taught to understand them, and to know that the beverage they made depended on how those changes took place, they would never produce a liquor worthy of the name of cider. It could be made quite equal to wine, as he had proved by experiment, having submitted specimens to a country gentleman and his friends, who could hardly be got to believe that it was made from apples. Very little was being done in England to improve the manufacture, but abroad they were studying carefully the chemistry of the apple, the fermentations that took place in the juice, and how to produce an excellent article. The result would be, that they would flood the market with an article superior to that made in England, and therefore it was high time that England learned how to make a cider which could not be excelled. Fermentation was produced by yeast, but there were numbers of different yeasts, each of which produced a different effect on the liquid in which it grew; but there was hardly a cider maker who knew anything about these yeasts. Abroad they found it worth while to isolate them and grow them in a pure state, and put them into the apple juice so as to make sure of the sort of fermentation which should occur instead of leaving it to any ferment which chanced to be there. What often happened to be there were a variety of substances which ought to be kept out. The first thing to teach was cleanliness, and next a certain amount of scientific knowledge was requisite if the best results were to be attained.

Mr. H. Y. Symons said he came rather to learn than to say anything, but he felt that the thanks of fruit growers and cider makers were due to the Society for taking up this subject, and he was greatly pleased to see the chair occupied by a gentleman who he believed came from his own county of Devon, and from the place where it was said the first orchard was planted, viz., Plympton. In old times cider was much more largely used than recently; but he believed the time would come when it would again become popular. He considered the grape was the king of fruits, and the apple the queen; and, therefore, they should all do what they could to encourage the use of cider as a natural and wholesome beverage. If would be a good thing if the legislature would pass a Bill enabling landowners to give greater encouragement to tenants to plant orchards, and to produce better kinds of fruit as the old sorts died out, which the majority of them did. Some very good fruit was grown in America, often he believed, from grafts from this country, but though they had more sugar than English apples, he thought they lost other qualities which were equally valuable, and he maintained that American cider was not equal in a medicinal point of view, to good English. Farmers should be better informed with regard to the right kind of manure to use in orchards; too much potash was detrimental, but nitrogen and phosphoric acid were essential. One reason why cider was not sold more was the system of tied houses, some brewers objecting to it being sold at all. He thought it would be well if cider were allowed to be sold by persons having a special licence, not publicans. It was a matter of opinion whether fruit-growers should send their apples or must to a large factory, where it could be fermented and prepared under scientific conditions on a large scale, or whether it should be made at home. There were certain advantages in the former plan, because the plant and utensils would be more carefully attended to, as in a large brewery; and cider, in fact, required more scientific treatment than beer.

Mr. J. Gaymer said he was much obliged to Mr. Cooke for the interest he had taken in this matter. He did not think they need really be much afraid of the foreigner, and with regard to chemistry, he thought it was most required for the detection of adulteration. He was quite sure that English cider would stand the ordeal of analysis much better than some, such as the American.

Mr. A. F. Godson, M.P., as a representative of Worcestershire, said he was interested in this question, and was very glad that Mr. Cooke was taking it up in a scientific way. He remembered the extraordinary methods which used to obtain in cider making in his early days. The apples were left lying about until no one had anything else to do; and then, when they had become decayed, and the pigs and fowls had had their fair share, what was left was considered quite good enough to make cider. He had always been a cider drinker, and believed it was one of the most healthy beverages. People in their district lived to a great age, and some complaints were utterly unknown. He did not say it was perfect; and in some constitutions it conduced to rheumatism, but a man who stuck to cider alone would never have gout. In the present time of agricultural distress, everything should be done to promote native industry. There was a great deal of truth in what had been said about fine old cider apples being allowed to die out, and very inferior sorts planted in their place. At one time, there was an enormous demand in Worcestershire for apples for Manchester; and he was informed that they were used to fix the aniline dyes used in the Manchester trade; and even the worst apples fetched a good price for that market, and this, to some extent, prevented the improvement in cultivation which ought to have taken place. He was glad to think, however, that a better state of things was coming about. The old, worn-out trees were being swept away, and very much better ones were taking their place. With regard to perry as showing what an excellent drink it was, he remembered an amusing incident. A railway porter was charged, and ultimately convicted of breaking open a case of champagne and stealing a bottle which he was seen to drink. He strenuously denied having taken any champagne, and on being sentenced repeated his denial, adding, "If ever I drank perry in my life that was perry."

Mr. H. Weston agreed with Mr. Lloyd that more technical education was required in connection with cider-making, and hoped that the county councils would do what they could in this direction.

Mr. E. Samson (Secretary Cider-makers' Association) said it could not be too much impressed on the farmers that almost on them alone depended the success of the cider industry. They must learn how to make a good article from the very beginning. In old times many people understood how to treat the apples both in the orchard, in the mill, and afterwards, but they were rapidly dying out; their knowledge was simply empirical, handed down from generation to generation, aided by their own experience; but few of such people remained, and matters had now to be conducted in a different and more scientific way, watching the changes which took place and finding out the why and wherefore of these changes, and the conditions necessary to be observed. When these facts were once thoroughly established there would be no difficulty in communicating them to anybody who could read, and who would give the necessary attention, and then the actual growers and makers of cider would be able to turn out a good article. It would never do to turn out a poor article in the first place, and then trust to chemistry to patch it up for the market. Practically, everything depended on the fermentation, and for

that, two conditions were essential, first cleanliness, and, secondly, an even and moderate temperature. Cleanliness could easily be learned by anybody, and with the aid of a thermometer there was not much difficulty in ascertaining the temperature, and in regulating it to a certain extent at very small cost. A moderately cold temperature was not so detrimental as too high a one, which would generally spoil the cider. Unfortunately in this country hardly anyone spent money or time in ascertaining scientific facts, most of what was known being derived from abroad; but so far as the growth of apples was concerned, we were on equal terms with any country in the world, and our climate seemed particularly suitable for the fermentation of apple juice; better, in fact, than the hotter climates of France and Germany. The association was endeavouring, in the first place, to organise the trade, and, secondly, to develop the taste for cider amongst the public, but as he had only been connected with it for a short time, he could not say very much as to the success which had attended their efforts. He could only say they were moving in several directions.

Mr. RADCLIFFE COOKE, in reply, said he was glad to hear that Mr. Lloyd was continuing his investigations, for although he was always rather afraid of chemists, he had no doubt these investigations would lead to useful results, especially if they were carried on in conjunction with experienced men, accustomed to cider-making. What was wanted was a thorough co-operation between the practical man and the scientific man. As to the pure ferments of course purity was always to be encouraged; but some people had said that the apple juice should not be allowed to ferment at all on its own account, because some of the apples might not be perfectly clean, and might have on their surface germs which might create difficulties afterwards. But it seemed to him that that would be perfectly unnatural; you ought, of course, to have both the fruit and all the utensils and vessels perfectly clean, but you must let the juice ferment of itself; he had no faith in depriving the apple juice of all its constituents in order to ferment it afterwards with something pure from somewhere else. Some of the stuff which he had drunk, supposed to be prepared in that way, was not like cider at all. With regard to Mr. Symons's suggestion about landowners giving facilities for the planting of orchards, he would remind him that, under the Act of 1883, if a tenant gave notice to his landlord of his intention to plant, and obtained his consent, he was entitled to compensation when he left the farm, to be determined by valuation. He also suggested that cider should not be made by the farmers, but in large factories. He did not doubt cider would ultimately be found in large manufactories or stores, in order that it might be blended and distributed over the country, but he was induced to take up the matter with a view of helping the industry of his native land, and he thought the small owners and occupiers ought to make their own cider on their own premises, in order to make a profit out of it. Then let Mr. Symons come and give them a better price for it than they could get now, and store and blend it, so as to send it out on the market of uniform quality. He did not want to see the small growers and makers ousted. It was mainly in their interest that the Association had been started; the success of its work would depend on the number of members and on the interest taken in it. Its chief utility would probably be in the publicity it gave; and he ventured to hope that great good would result from the present discussion. They wanted to enlist the aid of all concerned in the trade, and to unite them in one object, that of establishing English cider in the market, and ousting that of foreign origin. Mr. Gaymer said he did not fear the foreign producer, but he was doing all he could to effect a footing. A very large American importer was very anxious to join the Association, but he was refused admission, and since then his agent had sought admission, but equally in vain. Their object was to aid the English grower and manufacturer, and he hoped that before long some substantial results would be achieved.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Cooke, which was carried unanimously, and the meeting adjourned.

Mr. ARTHUR MONTEFIORE, F.G.S., writes:—Some years ago I had the honour of reading a paper before this Society on fruit-growing in Florida, and now, as one born and bred in the cider country of Wessex, I trust I may be permitted a few words on this important and highly potential industry of agricultural England—with particular reference to a point which in the discussion has as yet escaped notice. I allude to the question of soil. Now, it is my opinion, this matter of soil is not one of the difficulties with which the cider-grower has to contend; for, granted some judicious manuring, and plenty of open earth round the roots of the trees, there are excellent varieties of apples suited to a clay soil, just as there are excellent varieties of apples suited to a loamy soil. In West Dorset, for example, that fine, red, sweet apple, the "Best Bearer," as it is fitly called, with its beautiful pink blossom, thrives best in heavy clay; while the second best apple, the "Streaky Grab" (not "Crab") — a green apple with a red blossom — requires loam. We always considered in the west country, too, that while a stiff clay soil was to be preferred for maturing the tree, a black loam would be more productive of a heavy crop. In a country like ours, with great variety of soil within a comparatively restricted area, this indifference as it were—I hope I am not putting it too strongly — on the part of the apple-tree to the soil is a matter for which the cider-maker

should be particularly grateful. In any case it is the climate — the season — which causes him his chief anxiety, and not the soil. In West Dorset they have a saying that an apple-tree is "up and down in a man's life," and this holds true to experience. We have heard to-night of the greater longevity of the pear, but I think that even the 100 years vouched for the apple-tree is too high an "average expectancy." At about 8 years the tree will begin to bear; at 16 years, say, it will produce a sack of apples; and at 30 years—when in its prime — I know from experience that four sacks of apples is a low average yield. Now four sacks of apples will make a hogshead of cider. But as the age of the tree approaches the ordinary limit of a man's life its fecundity ceases and sterility draws near; at threescore years and ten it cumbereth the ground. In conclusion, I may mention that there are several points in the manufacture of cider in the west country which offer a contrast to the system employed in Herefordshire as described by Mr. Ratcliffe Cooke—to whom all interested in apples and the agricultural problem now ever with us, must feel indebted for his valuable efforts. Particularly should I like to express my appreciation of his desire to benefit the small producers, and to conserve their industry; for reformers are too fond of bureaus and centralisation, and in building up a lofty, intangible castle in the clouds, not unusually overlook the lowly but very tangible farms and granges on the land. I take it that we want to benefit not so much some great Cider Exchange, or the middle men, but rather the villages and the villagers. And while the best way to do that is to so improve the supply as to develop and justify the demand, perhaps I may be permitted to point out that in bringing about this improvement the Cider Makers' Association will find its own justification.

Miscellaneous.

WOOD-PULP MOSAICS.

A process has lately been invented in Germany for manufacturing floor mosaics from wood-pulp. It is claimed that this process is distinguished from the known processes of manufacturing sectional or mosaic floors by reason of the fact that the sections made according to it are not liable to any change of temperature, and are, nevertheless, not like stone, but similar to wood in all essential qualities. Consul Stern, of Bamberg, says that the process is as follows:—Several particles of wood, such as saw-dust, fine shavings, &c., are soaked in a mixture of shellac and alcohol, so that the pores of the wood are penetrated and thoroughly dried. A cement, consisting of fresh cheese whey and slacked lime, is then prepared. This cement is thinned with water, and then mixed thoroughly with the already dry wood particles in such a way that the consistency of the mass is uniform. Particular care is taken to render the cement as thin as possible, so that it will distribute itself easily and uniformly, and enclose each particle of wood as perfectly as the shellac solution. The mixture thus produced is allowed to dry until it is only moist, not thoroughly dry as before, for in the latter case the curd would lose its cohesive power. The moist pulp is then put into heated mosaic moulds of the desired shape and size, and in these forms placed under the press. As a result of the heat the shellac softens, regaining its adhesive powers, and the curd cement hardens rapidly, so that both of the substances, the shellac as well as the cement, unite under the pressure so perfectly with the wood particles that the wood mass resulting may within a few minutes be taken out of the moulds without losing the form received. After the cooling process and complete hardening, these mosaics, it is claimed, are far less susceptible to any change of temperature or moisture than any natural wood. It is necessary that the use of every other ingredient, especially if of an oily or fatty character, should be avoided in this character, as otherwise the close union of the shellac with the curd cement would be retarded or even prevented. Wood-pulp, for the manufacture of multi-coloured mosaics, is prepared in the following manner:—The particles of different varieties of wood are put through the process separately, so that the natural colour of the wood itself is brought into prominence. Dyes dissolved in alcohol are mixed with the shellac solution before the wood particles are coated. The wood particles are first coloured with dyes, dissolved in water, and allowed to dry well before the coating with the shellac solution. For simple floors it suffices to manufacture mosaics of different colours, changing them at pleasure, so as to form a variety of patterns. The manufacture of pattern or fancy wood mosaics is proceeded with as follows:—Pattern moulds of the required design, divided into fields and figures, are fitted into the plain mould; each section of the design is filled with the wood-pulp, dyed as before described, and the pattern mould removed, after which the whole, thus freely outlined, is subjected to heat and air pressure as before mentioned, the result being perfect vari-coloured, fancy mosaic. This wood mosaic, in spite of its hardness and resisting qualities, still retains all the essential properties of wood, being thus particularly well adapted for use as floor covers in living-rooms, and similar purposes.

Correspondence.

FURNACES FOR ROASTING GOLD BEARING ORES.

The THWAITE-DENNY SYNDICATE write:—The value of a thorough and oxidising roast of pyritic

auriferous ores, whether as a preliminary process to mercuric amalgamation, to the application of cyanide with oxygen, or with a halogen, is well recognised, and quite justifies Mr. Lock's trouble in preparing a paper on the subject of "Furnaces for Roasting Gold Bearing Ores." We, however, lay claim to a knowledge of the Denny furnace which Mr. Lock describes, and must ask his pardon for objecting to the terms of his friendly criticism. The wear and tear of the internal ironwork is not "exceedingly rapid;" that the furnace is a good and serviceable one many students of the famous Ballarat School of Mines can testify to, because the Denny furnace has been the furnace in use in this mining educational centre for some years, doing very good work. Its comparative smallness of output is against it, but this defect we claim to have removed in the Thwaite-Denny roasting plant, which we consider superior in design to any other.

Obituary.

HYDE CLARKE.—By the death, on Friday, 1st inst., of Mr. Hyde Clarke, the Society of Arts loses a most active member, and one who was for many years intimately associated with its work. He was elected a member in 1855, and was a constant contributor to this *Journal* from that time. He was a member of the Council in 1868, treasurer 1869-70, a member of the Council from 1871 to 1874, and a vice-president from 1875 to 1879. In 1857 he proposed the formation of special sections of the Sociery—one for India, one for Australia, one for English America, and so on (see *Journal*, vol. v. p. 373). The proposal was referred to a committee, but no immediate action was taken. Some years afterwards, however, largely through Mr. Clarke's continued advocacy of his scheme, the Indian and African Sections were formed. The India Committee was formed in 1869, and the conferences organised by this committee grew into the Indian Section. On April 1, 1870, Mr. Clarke opened the Conference on the "Through Route to India," and on subsequent occasions he read several other papers before the Section. The African Section was formed in 1874, and from the formation of these sections Mr. Clarke was a member of the committee of both. He was also greatly interested in the examination work of the Society, and devoted much thought to proposals for spreading a knowledge of modern languages. In 1869 he wrote a memorandum on a "proposed *viva-voce* Examination in Modern Languages," which was issued by the Council to Local Boards (*Journal*, vol. xvii. p. 797).

Mr. Clarke was born in London in 1815, and at an early age he made a special study of the engineering works of Holland. In 1836, he planned and surveyed the Glasgow and South-Western Railway, with the Morecambe Bay Embankment, and in a paper on the "Reclamation of Land on the North-Western Coast of England," which he read before the Society in February, 1884, he specially referred to his proposal for the embankment of Morecambe. In 1849 he published "Engineering of Holland Dykes" in "Weale's Quarterly Papers on Engineering." In the same year he was employed to report on the telegraph system for India, and in 1857 he exerted himself for the extension of hill settlements and railways in India. He spent some years in Smyrna, and on his return to England was engaged in founding the Council of Foreign Bondholders, of which he was long the secretary. Mr. Clarke was a prolific author of papers and pamphlets on a large number of subjects. In 1837 he commenced to write for the Society of Useful Knowledge, and wrote articles in the "Civil Engineers' and Architects' Journal" (1840), and other journals. He was a considerable linguist, and is said to have had some knowledge of one hundred languages. His "New and Comprehensive Dictionary of the English Language as Spoken and Written," first published in Weale's Educational Series, is a very useful and handy volume. He claimed that it contained far above a hundred thousand words, or 60,000 more than any dictionary previously published. Mr. Clarke was an active member of the Council of the Royal Historical Society, and took a prominent part in the "Domesday" (1886) and Gibbon (1894) Commemorations.

The wide range of his attainments, and the varied nature of the subjects in which he was interested, made him a familiar figure in many different circles. His advanced years, which seemed to affect but slightly a very keen and tenacious memory, made him, in more than one society, a link with the history of the past whose absence will for some time be greatly regretted.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

MARCH 13.—"The Meat Supply of the United Kingdom." By E. MONTAGUE NELSON. SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

MARCH 20.—"The Progress of the Abattoir System in England." By H. F. LESTER, Hon. Secretary to the London Model Abattoir Society. SIR BENJAMIN W. RICHARDSON, M.D., F.R.S., will preside.

MARCH 27.—"Modern Photogravure Methods." By HORACE WILMER.

APRIL 3.—"Sand Blast Processes." By JOHN J. HOLTZAPFFEL.

Afternoon Lecture.

Thursday, March 14, at Half-past Four.—"Art Tuition." By Prof. Hubert Herkomer, R.A.

Indian Section.

Thursday Afternoons, at Half-past Four o'clock:—

March 28.—"Chitral and the States of the Hindu Kush." By Capt. F. E. Younghusband, C.I.E. The Hon. George Curzon, M.P., will preside.

Foreign and Colonial Section.

Tuesday evenings, at Eight o'clock:—

April 2.—"My Recent Voyage in Siberia." By Captain Wiggins.

May 21.—"Commercial Education in Belgium." By Professor William Layton.

Applied Art Section.

Tuesday Evenings, at Eight o'clock:—

March 19.—"Practical Carpet Designing." By Alexander Millar. J. Hungerford Pollen will preside.

Cantor Lectures.

Monday Evenings, at Eight o'clock:—

Dr. D. Morris, C.M.G., "Commercial Fibres." Three Lectures.

March 18.—Lecture I.—Cellulose and non-cellulose constituents of fibres—Chemical tests for cellulose—Comparative estimation of fibres—Pure cellulose in cotton, kapok, vegetable silks, and seed-hairs—Bast fibres of dicotyledonous plants—Fibre - bundles and ultimate fibre - cells—Higher textile fibres: Flax — Hemp — Calotropis — Sunn-hemp — Marsdenia — Sida — Nettle fibres: China-grass — Rhea—Nilgiri nettle — Pua-hemp — Ban-rhea—Urera—Lower textile fibres: Indian jute—Chinese jute—American jute—Abroma—Abutilon fibres—Deccan hemp—Roselle fibre—Ban-ochra—Helicteres—Pavonia and malvaviscus fibres.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 11...Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Mr. J. G. Scott, "The Post-office Money Order Business, its defects, and inventions for its improvement." 2. Mr. William Ireland, "A Portable Copying Press." 3. Mr. John Whitelaw, "An Improved Pump Bucket and its economy." 4. "A Graphic Method of recording Weather Observations."

Imperial Institute, South Kensington, S.W., 8½ p.m. Prof. C. Le Neve Foster, "Slate and Slate Quarrying."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. S. L. Hinde, "Three Years' Travelling and Fighting in the Congo Free State."

British Architects, 9, Conduit-street, W., 8 p.m. Special General Meeting.

Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, March 12...North-East Coast Institute of Engineers and Shipbuilders, Literary Society's Room, Fawcett-street, Sunderland, 7¾ p.m. 1. Discussion on Mr. W. C. Mountain's paper, "The Design and Efficiency of Plant for the Transmission of Power by Electricity." 2. Discussion on Mr. Henry Foster's paper, "The Application of the Electric Arc to Machinery and Boiler Repairs," &c. 3. Mr. S. O. Kendall, "Turret-deck Cargo Steamers."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "Internal Framework of Plants and Animals." (Lecture IX.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. A. Newshole, "Nature of Nuisances, including Nuisances the Abatement of which is Difficult."

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Mr. T. R. Dallmeyer, "An Unconsidered Property of Photographic Lenses."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Capt. Younghusband, "The Kashmir Frontier."

Asiatic, 22, Albemarle-street, W., 4 p.m.

Wednesday, March 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. E. M. Nelson, "The Meat Supply of the United Kingdom."

Sanitary Institute, Parkes Museum, Margaret-street, W., 8 p.m. Discussion on "Back to Back Houses."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Japan Society, 20, Hanover - square, W., 8½ p.m. Mr. G. C. Haité, "The Crysanthemum in Japanese Art."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m. Annual Meeting.

Thursday, March 14...SOCIETY OF ARTS, 4½ p.m. (Special Lecture.) Prof. Hubert Herkomer, "Art Tuition."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Civil and Mechanical Engineers, 12, Delahay-street, Westminster, S.W., 7 p.m. Mr. S. à Court, "Lifts, Hydraulic and Electric."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. S. R. Gardiner, "Three Periods of 17th Century History." (Lecture II.—The Commonwealth.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. M. S. Keith, "The Electrolysis of Gold."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. C. B. Clarke, "Khasia."

Camera Club, Charing-cross-road, W.C., 8 p.m.

Friday, March 15...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Professor Roberts-Austen, "The Rarer Metals and their Alloys."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Professor Bostock Hill, "Trade Nuisances."

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, March 16...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Waves and Vibrations." (Lecture III.)

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No. 2,208. Vol. XLIII.

FRIDAY, MARCH 15, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1895 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before the 13th of April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit for promoting Arts, Manufactures, or Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For.Memb.R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., P.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (now Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (now Lord Masham).

In 1887, to HER MAJESTY THE QUEEN.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph Lister, Bart., F.R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

PRIZES FOR PHOTOGRAVURE.

[Attention is drawn to the two slight alterations in the conditions of the offer printed in italics.]

With the view of encouraging the development of Photogravure in this country, the Society of Arts offer the following Two Prizes :—

(1). A Prize of Twenty Pounds or a Gold Medal* for the best reproduction of a selected picture by a Photogravure process.

(2). A Prize of Ten Pounds and a Silver Medal for the best Photographic Negative of a selected picture, suitable for reproduction by a Photogravure process.

The following are the conditions of the offer :—

The offer is limited to British subjects.

The Committee have selected as a suitable test picture, Mulready's "Choosing the Wedding Gown," now in the South Kensington Museum, and the Lords of the Committee of Council on Education have kindly consented to allow the picture to be used for the purpose.

Competitors will be allowed to photograph the picture, which will be placed for the purpose in the Photographic Studio of the Science and Art Department.

* Should the winner of the prize elect to take the award in money, a Silver Medal will be given in addition to the sum of Twenty Pounds.

Competitors should apply to the Secretary of the Society of Arts, who will provide them with an order to photograph the picture, and will also see that the necessary arrangements for the purpose are made. Such applications must be received not later than the 30th March. A dark room is attached to the studio so that competitors can develop their plates on the spot.

Competitors for Prize No. 1 will be expected to send in a finished proof from the plate, the plate itself, and the negative from which the plate was made.

Competitors for Prize No. 2 will be required to send in the negative and a print from it. (This print may be in silver, carbon, platinotype, or other process.)

The negatives for both prizes must be taken on plates 12 × 10 inches, and the finished picture must be of corresponding size. The actual size of the original without the frame is about 21 × 18 inches.

The photographs and photogravures must be wholly untouched. Any work on the negative, *positive*, or plate will be held to disqualify the competitor.

The prints, plates, and negatives must be sent in to the Society of Arts not later than the 15th of May next.

The winner of Prize No. 1 will not be disqualified for Prize No. 2.

The taking of the negative, and the production of the plate, need not be the work of the same person.

The photographs, negatives, and prints will be returned to the competitors after the decision of the judges has been announced, but the Council of the Society reserve to themselves the right of exhibiting all or any of the works sent in.

The judges will be the Committee nominated by the Council:—Major-General Sir John Donnelly, K.C.B., Chairman of the Council; Sir Frederic Leighton, Bart., P.R.A., H. T. Wells, R.A., E. J. Poynter, R.A., Francis Cobb, Thomas Armstrong, Capt. W. de W. Abney, C.B., F.R.S., and Sir Henry Trueman Wood, Secretary.

The Council reserve to themselves the right of withholding either or both of the prizes, or of awarding smaller prizes, if they think it desirable to do so. The Council also reserve the right of declining to accept, at their discretion, any application for orders to photograph the picture.

The Council will not be responsible for any loss of, or damage to, works sent in.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, March 5, 1895; Sir EDWARD HILL, K.C.B., M.P., in the chair.

The paper read was—

COLONIES AND TREATIES.

By SIR CHARLES M. KENNEDY, K.C.M.G., C.B.

Vice-President of the Society.

The subject which I have the honour to bring before the Society this evening is of a technical nature, and relates to questions of constitutional and international law and practice. The subject really lies within a narrow compass, and the paper is therefore shorter than usual.

The expansion of the British Colonies, and the large measure of management of their own affairs which this expansion has brought about, gives rise at the present time to colonial questions widely different from those of previous centuries. The object of this paper is to explain certain important questions of recent growth, not to enter upon subjects of controversy and policy, nor to discuss matters which have become part of the history of past times. The development of the Colonies has (more especially in view of present conditions of commucication between different parts of the world) given prominence to their relations with foreign powers. Colonies come under the engagements of the various treaties contracted by the country to which they belong. The political and general engagements of the mother country apply to them. They do not possess, any more than the several counties, departments, or provinces of the mother country, separate political existence towards other nations. A colony cannot conclude any international arrangement with a foreign country, unless with the express sanction of the home government. On the other hand, the case is somewhat different as to matters of administration. The postal and trade requirements of particular colonies have rendered necessary in recent years either the conclusion of special arrangements applicable to them, or exceptions with respect to them in the operation of treaties concluded by the mother country: for example, the geographical position and the products of the British and Spanish West Indies now bring them within the sphere of trade controlled by the United

States. And again, the self-government now enjoyed by many British colonies requires special provisions in order to meet the conditions of their social organisation. Their internal policy is not necessarily identical with that of the United Kingdom; and engagements entered into with regard to commerce, copyright, nationality, navigation, seamen deserters, and trade marks, adapted to the circumstances of the United Kingdom, sometimes conflict with the laws and policy of particular colonies. There may have been natural and proper reluctance on the part of European Governments to admit exceptions to their general engagements, until a sufficient case was made out; but, at all events as far as England is concerned, when the necessity for special arrangements was demonstrated, her Majesty's Government readily gave effect to them. The Reciprocity Treaty of 1854 to regulate commercial intercourse between Canada and the United States, and the Treaties concluded at Washington in 1872 and 1888 are "leading cases" in such matters. Many postal agreements relative to communication between colonies and foreign countries have been concluded as circumstances rendered expedient, from 1867 to the present time. In 1878 a treaty relative to India was signed with Portugal. In December, 1891, an arrangement was entered into with the United States, by means of an exchange of letters, on behalf of the British West Indian colonies, with the view of securing for them the benefit of the Reciprocity Article of the McKinley Tariff Act of 1890, under which sugar would enter the United States free of Customs' duty.

In negotiations with France and Spain on behalf of Canada, in order that the colonial case might be stated with authority and fully, the High Commissioner of the Dominion in London has been constituted plenipotentiary jointly with her Majesty's ambassador. A commercial convention relative to trade between Canada and France was concluded in April, 1893; legislative sanction to it has been given in both countries, though it is not yet in operation. Spain has not yet been in a position to proceed with similar negotiations. British Colonies take part, as possessing independent administrations, in postal, tariff, and telegraph congresses; and they have also on this ground been admitted to certain diplomatic conferences. I had, myself, the privilege at Paris, in October, 1883, to bring into a conference of 31 nations, on the subject of the protection of submarine telegraphs, the High Commissioner of Canada and the delegate of India, as the representatives of these two Governments, on a footing of equality with the representatives of independent States. The Hon. Sir Charles Tupper, Bart., G.C.M.G., C.B., and the late Sir John Bateman-Champain, R.E., K.C.M.G., who acted in that capacity, rendered good service, and proved that colonial representation may much strengthen Great Britain. These examples, together with the formation of the South African Customs Union, indicate that British Colonies and possessions exercise, in regard to negotiations they wish to enter into, liberty of action, while they enjoy the advantages which the position and influence of Great Britain confer. In connection with this part of the subject, it is to be mentioned that Spain concluded, in July, 1891, an arrangement with the United States, under the McKinley Tariff Act, relative to Cuba and Porto Rico. The general policy of Continental Powers is to subordinate the interests of their colonial possessions to those of the mother country; to keep colonial trade as much as possible in their own hands, and, whenever the provisions of their treaties are likely to be at variance with this policy, to restrict the application of their treaties so as to prevent any such result.

To return to our main subject. Treaties are often concluded under circumstances which do not admit of the delay which correspondence with distant authorities involves; and, further, it is not possible to negotiate during a public discussion of the stipulations of a proposed treaty. To meet the present condition of things, her Majesty's Government have adopted a Colonial article which, after reference to the Colonial and India offices, is now inserted in new treaties relative to commerce and navigation, copyright, nationality, seamen deserters, and trade marks. Its wording is as follows—quoted from the 19th Article of the Treaty with Japan of July 16th, 1894:—"The stipulations of the present treaty shall be applicable, so far as the laws permit, to all the colonies and foreign possessions of her Britannic Majesty, excepting to those hereinafter named, that is to say, except to India, the Dominion of Canada, Newfoundland, the Cape, Natal, New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, New Zealand. Provided always that the stipulations of the present treaty shall be made applicable to any of the

above-named colonies or foreign possessions on whose behalf notice to that effect shall have been given to the Japanese Government by her Britannic Majesty's representative at Tokio within two years from the date of the exchange of ratifications of the present treaty."

The negotiation of the Treaty of July 16th, 1894, with Japan, marks a further advance in international arrangements with regard to the colonies. The second Article provides that the subjects of the contracting parties shall be exempted from military service and its attendant obligations. In colonies where there is a large alien population exemptions of this nature cannot safely be allowed, and such colonies are therefore precluded from acceding to the Treaties which contain stipulations securing these exemptions. By means of an exchange of notes, the Government of Japan agrees that any of the British Colonies and foreign possessions enumerated in the Colonial Article may accede to the present Treaty "under the condition that notwithstanding such accession they shall not be bound by the stipulations of Article II."

The colonial article seems sufficient for its purpose. The only remark to be made on it is that, possibly, the Colonies may hereafter ask that the faculty shall be reserved to them of withdrawing from treaties at stated periods—in other words, that a treaty may be made terminable as well as operative for colonies severally, whereas at present no notice of separate termination for a portion of the empire can be given.

Such is the position of the main question dealt with in this paper. Some observations may, however, be expected with regard to the most favoured nation clause; and the provisions of two treaties which contain exceptional stipulations respecting the trade of British Colonies, namely the Commercial Treaty of July 23, 1862, with Belgium, and the Commercial Treaty of May 30, 1865, with the Zollverein. These stipulations are as follows: Belgium Treaty Article XV. "Articles, the produce or manufacture of Belgium, shall not be subject in the British Colonies to other or higher duties than those which are or may be imposed upon similar articles of British origin." Zollverein Treaty, Article VII. The preceding stipulations of the treaty are made applicable to the colonies and foreign possessions of her Britannic Majesty; and it is further specially provided that "in those colonies and possessions the produce of the States of the Zollverein shall not be subject to any higher or other import duties than the produce of the United Kingdom of Great Britain and Ireland, or of any other country of the like kind." The general effect of the stipulations of these two treaties is well stated in an answer to a question in the House of Commons given by Sir Edward Grey, July 30, 1894: "(1) they do not prevent differential treatment by the United Kingdom in favour of British Colonies; (2) they do prevent differential treatment by British Colonies in favour of the United Kingdom; (3) they do not prevent differential treatment by British Colonies in favour of each other." While these two treaties remain in force, the engagements contracted under them are extended to other Powers that have a commercial treaty which contains a most favoured nation treatment clause applicable to the British Colonies. Full information on this point is afforded in the Blue Book Commercial, No. 17, of 1893; presented to Parliament at the instance of our Chairman, who has for many years given much attention to colonial questions. It is sufficient to say here that the exceptions are few. They appear to be (1) Brazil and one or two countries of minor commercial importance with whom we have no treaty relative to trade now in force; (2) China, the Sandwich Islands and Siam—whose treaties do not apply to colonies; (3) certain limitations in the case of France, the Netherlands, the United States of North America, and Muscat, the application of whose treaties in regard to British Colonies is restricted.

The most favoured nation clause does not in itself convey an engagement to confer any particular or special rights. Its object is to prevent differential treatment to the detriment of the country in whose treaty the clause exists, in the matter to which that clause applies; in other words, it secures the Power with whom this engagement is contracted against any inferiority of treatment in relation to other foreign nations in matters regulated by the terms of the clause. The mother country and her colonies, however, are not foreign nations with respect to each other. The most favoured nation clause thus does not preclude special arrangements between the mother country and her colonies, or between these colonies. It is altogether apart from and beyond questions connected with their mutual intercourse. Such questions are entirely matters of policy to be determined by the home and colonial Governments. Any country is entirely at liberty to place trade with its colonies on a different and

more favourable footing than it places foreign trade. The existing tariffs of France, Portugal, and Spain may be cited as instances of present practice in support of this view.

It would be outside the scope of a paper read before the Society of Arts to enter into the political questions arising out of the engagements contracted under the Belgian and Zollverein Treaties above referred to, which were brought before the Ottawa Conference of 1894, in continuation of previous representations. It is sufficient to say that the subject is complex. It is not limited to the provisions of these treaties; the principles to which their provisions give expression are also embodied in certain colonial laws, and in one or more Acts of Parliament. Thus the termination of these treaties would not in itself suffice to bring trade within the empire on a general basis of more favourable treatment than trade with foreign countries. Their termination would not operate so as to establish a British Zollverein without an extensive alteration in the laws and fiscal systems of the component parts of the Empire.

A Bill was introduced into the House of Commons last night to amend, as regards the Imperial Parliament, certain laws affecting the Australian colonies, to enable them to enter into more direct communication with other British possessions.

In my own personal opinion, the action of her Majesty's Government in recent years with respect to colonial questions offers abundant and sufficient proof of the earnest desire of England to draw closer the relations between the mother country and the colonies, and to do justice to all British dependencies. When a change of policy is sought, it is only reasonable to ask that in a matter where united action on the part of the self-governing colonies is essential in order to carry it into effect, a clear and definite plan shall be generally accepted by the principal Colonies before the Home Government is expected to adopt such change of policy. Any proposal of this nature has to be fully considered in its relation to other consequences which it may involve. When, however, it is made in a formal shape, I, personally, feel confident that it will not fail to receive the careful and best attention of the people and Government of the United Kingdom.

DISCUSSION.

Sir CHARLES TUPPER, Bart., G.C.M.G., C.B., said this paper, though brief, was very interesting and important, showing, as it did, the progress which had been made in cementing and extending the relations between the Imperial Government and the autonomous colonies of the Empire. The writer had referred to the occasion of the international conference in Paris for the protection of submarine cables, where no less than 31 nations were represented, and where, for the first time, he (Sir Charles Tupper), as representative of the Dominion of Canada, was present on an equal footing with the representatives of other nations. He well remembered the part which Sir Charles Kennedy took on that occasion, and how, even long before that, he had shown the deep interest he took in all matters relating to the colonies, and especially in the important change which was made by her Majesty's Government in recognising the position of the autonomous colonies and of Canada as entitled to express their views in connection with the negotiation of treaties, as shown by his own appointment as plenipotentiary in the negotiation of treaties with Spain and afterwards with France. No one exercised more influence in bringing about that happy change than Sir Charles Kennedy, who was then the head of the commercial department of the Foreign-office. There had been some discussion in the House of Commons in Canada, as well as elsewhere, on the desirability of allowing the autonomous colonies to negotiate treaties for themselves, but he believed that question had been entirely set at rest by the action to which he had referred, by which, where the interests of a colony were especially concerned, a representative of that colony was selected as one of the British plenipotentiaries. The experience which had grown out of this had induced the belief in all the colonies that, instead of being an advantage to a colony to be allowed to approach a foreign Government on its own account in connection with commercial matters, its position would be immensely strengthened by the representative of the colony being appointed a plenipotentiary in conjunction with her Majesty's ambassador, so that the views of the colony were not only fully represented, but were backed up by the authority and influence of the mightiest empire in the world. The negotiation of independent treaties by colonies was not only impracticable, but would hardly be in the best interests of the colonies themselves, but, apart from that, the empire was one and indivisible, and must be regarded as a whole, and the interests of any colony must be represented in conjunction with the views and interests of the great empire to which it belonged. In connection with the treaty recently negotiated between this country and France, when he served as plenipotentiary, in conjunction with the Marquis of Dufferin, he thought some misapprehension had arisen in some of the colonies with regard to its effects. The treaty was not only successfully negotiated, but it had been adopted by an overwhelming majority in Canada, and by a large majority in the French Chambers. There was an

impression in some quarters that under that treaty France would be entitled to enjoy any advantages which might be accorded by one colony to another, so that when the Bill to which reference had been made became law if the Cape, or any of the Australian colonies, or Canada made any reciprocal treaty arrangements, France would be entitled to enjoy the same advantages. But that was an entire misapprehension; any advantage given to any third power would be enjoyed equally by France, but arrangements between Great Britain and her colonies were excepted, and the treaty did uot in the least interfere with free trade being established between the Cape or any of the Australian Colonies and Canada without similar privileges being accorded to the Republic of France. So far as the Belgian and German treaties were concerned, their effect had been very clearly stated in the paper, and the recent statement of the Under Secretary for Foreign Affairs had placed the matter in the clearest possible light. Any person reading that statement as to the effect of the German and Belgian treaties must feel that it was an anomalous and very undesirable state of affairs, that while Great Britain might give special commercial advantages to her colonies, no one of those self-governing colonies could adopt a similar course and give any advantage to the mother country. He believed the history of the world would be searched in vain for any parallel to such a state of things; but he should like it to be borne in mind that that position settled a question which was constantly raised in England with regard to colonial tariffs. He would not go outside the scope of the paper and discuss the question of policy of raising revenue by a customs tariff, but it must be remembered by those who said that the colonies made a poor return to the mother country in treating her products in the same way as those of foreign countries, that under these treaties they had no option. If they were obliged to raise their revenue by a customs tariff, and if in that tariff they might favour the mother country, as again and again they would have been glad to do, the Government would be obliged to disallow the Act because this country had bound itself by treaty with Belgium, Germany, and all other countries which had a "most favoured nation" clause, that the colonies should not give to England any advantages which they did not equally accord to those countries. As he had said, that state of things was anomalous, and ought to be altered. Not only had Lord Salisbury, in answer to a deputation on the subject some years ago, said it would be the constant care of the Government to seize the earliest opportunity to terminate that portion of those treaties, or to obtain a modification of them; but he was glad to say that the representative of the colonies in the present Government, on a recent occasion in the House of Commons, expressed the same desire. He could not think that there was so much difficulty as was sometimes supposed in obtaining such a modification. Any one who looked at those treaties would see that the advantages were so enormously on the side of Germany and Belgium, that it was not unreasonable to suppose that, if a firm representation were made to the Governments of Belgium and Germany, that it was found desirable to modify this clause, they would agree to any reasonable modification rather than jeopardise the whole treaty. The most conclusive evidence that what took place then would never occur again was that her Majesty's Government had long since conceded to the colonies the right of being consulted before being included in any treaty made by this country. In the case of the treaty recently made with Japan, it was clearly stated that it did not apply to India or the self-governing colonies, unless they took measures to bring themselves within its scope; and he was sure this would receive the approval of every one who desired to see the close relationship between the colonies and the mother country on which the future greatness of this great Empire very largely depended. At the present moment negotiations were going on between South Africa and Canada for closer trade relations, and he was quite certain that, as soon as the Bill which had just been introduced became law, similar negotiations would take place with the Australian colonies. Next to the importance of drawing closer the relations between the colonies and the mother country came the importance of drawing closer the ties between the great outlying portions of the Empire with one another. He would conclude by expressing the obligation which all the colonies owed to Sir Charles Kennedy for his long and zealous efforts in this direction.

Mr. ROBERT NIVEN said it was a happy omen that those who represented the colonies and those who represented the mother country were so much at one. He was not quite sure that he should agree with Sir Charles Tupper that the money raised by customers in the Australian colonies was raised for revenue purposes only, though it was defended on that ground. His idea was that the tariff was imposed for the purpose of protection, at any rate in Victoria. He did not say that they had not a right to protect themselves, and it had been said by an eminent authority that no young country without protection at first had ever succeeded. He presumed what Sir Charles Tupper desired was that the colonies should be able to afford certain advantages to the mother country, not to admit her products free of duty altogether. That would not call for very much patriotism on their part. He thought the spirit in which Great Britain had acted towards her colonies in recent times had on the whole, as compared with her earlier treatment of them, been admirable. Before the American war of independence an English statesman said that the colonies had no right to make even a nail without permission from England, but now we treated the colonies very much as a mother treated a spoiled child. He had not travelled much in Canada, but he had spent some years in

Australia, and he must say he did not find much devotion to the mother country or much loyalty to England there. They would send a few troops on a special occasion to support our own forces, but there was no disposition to make a proper contribution to the navy, or to range themselves in line as members of a great Empire to which they were proud to belong, and undertake their fair share of the burden of the Empire. He thought it was high time that the home Government let them understand, in a mild but firm way, that that was what was expected of them. With regard to the suggestion in the paper that a colony should be at liberty to withdraw from a treaty into which it had entered, he presumed it only meant on giving due notice, and he hoped Sir Charles Kennedy would expiain that a little further. Take the case of the relation of Australia to China. We forced China to open certain ports to trade, which was much against her wish, and, in return, undertook to keep certain ports open to the Chinese. Now, the Chinese were very industrious and frugal; they would, in many cases, make a profit or a living where Englishmen or Scotchmen could not, and, in consequence, in certain colonies, notably in Queensland, there was a very strong feeling against them, and Bills were passed for what was called "regulating" the admission of Chinese, the real object of which, however, was to exclude them. They had no more right to pass such Bills than the three tailors of Tooley-street had to break laws, and Lord Carnarvon at first refused to sanction it, but by continual persistence, they at length obtained their end.

The CHAIRMAN said he had listened with great interest to this paper, by a thorough master of the subject; all the more so, as he had the honour of serving on the Trade and Treaties' Committee in the House of Commons not long ago. He thought there were very few now who ventured to depreciate the immense importance to the mother country of her colonies. He had not visited many of them, but he had been to Canada, and he must confess to a great feeling of pride, when he arrived in Montreal, that his own countrymen mainly had been the means of producing that magnificent city in such a short period; for 100 years ago there was hardly any Montreal at all. Now there was a grand city, with magnificent buildings and streets, and every possible sign of commercial prosperity and activity. He did not know what the feeling might be in Australia, but in Canada there was the greatest possible feeling of loyalty and devotion to the mother country. In criticising the action of the colonies, it must be remembered that there might be circumstances connected with their internal life which naturally somewhat tended to clash with their relations to the mother country, and might very well be believed to diminish that loyalty which he believed burned so brightly among them. It was a matter of great pride to this country that it should have succeeded in a way no other country, either ancient or modern, had done in the great task of colonisation. Rome, to a certain extent, was successful in that direction, but what were the colonies of Rome compared with those which owed allegiance to Great Britain. It was greatly to the advantage of the colonies and of this country to cultivate those close ties of relationship, and he should be sorry to see the continuance of any treaty clauses such as had been already alluded to, which restricted the action of the colonies in any way. The colonies were our best customers, and England badly wanted customers, and unless we could get them our own prospects were not of the brightest. He should very much like to see established what was called in Germauy Zollverein, if possible, but he was not blind to the difficulties which existed. Still, our sympathies ought to be enlisted in that direction, so as to facilitate the interchange of products between the colonies and England. He was quite sure, from what he heard on the Committee of the House of Commons, that there was a consensus of feeling amongst all statesmen in favour of modifying those unfortunate clauses in the Belgian and German treaties. He felt sure that there existed on the part of the colonies a feeling which was now fully reciprocated by the mother country, such as ought to exist between a mother and her children. He would not venture to touch on the question which had been raised about the Chinese. He had seen the Chinese in various parts of the world, and knew their great industry, application, and economy, and possibly we might take some useful lessons from them. He quite agreed that the British workmen were superior to the Chinaman, but there was a question which he would not venture to go into, whether there was not a tendency in these days, by artificial restriction, to deprive the British workman of the natural superiority which he possessed, at any rate, in considering the problem of labour, the question of Eastern labour would have to be considered. Whether it was wise to attempt to exclude Chinese labour he did not know, but he had been told that the magnificent Canadian and Pacific Railway would never have been made had it not been for Chinese labour; at any rate, it was a very important factor in its construction. It was quite possible, however, that the conditions of life in the colonies might be so agreeable to the Chinese that they might be tempted to come in and swamp the English, and, under such circumstances, one could not wonder at a colony making regulations as to the number which should be admitted. He was in hopes, however, that one of the results of the great war now going on would be the opening up of commerce in China, and that it would be beneficial to all parties. It was of the utmost importance, when treaty negotiations were going on, that the colonies should be properly represented if they were to be bound by th treaty. In conclusion, he could not help feeling regret that Sir Charles Kennedy's ripe experience

was no longer in active force at the Foreign-office, but he knew that his patriotism was such that, if his advice and experience were at any time wanted, it would always be at the disposal of the country. He begged to propose a cordial vote of thanks to him for the paper.

The vote of thanks having been carried,

Sir CHARLES KENNEDY, in reply, said the only point upon which further information had been asked was with regard to the power of the colonies to withdraw from treaties at stated periods. By the Colonial Article, the accession of the self-governing colonies was dependent on their decision that the treaty should apply to them, but as it now stood, if a colony once acceded to a treaty, it had no means of withdrawing therefrom afterwards; it could only be terminated as a whole by an act of the Imperial Government. What he rather looked to as a provision in the future was that the colonies should not only have the faculty of acceding to each treaty, but also of withdrawing from it. Treaties are usually concluded for a term of years, and twelve months before the expiration of the period, notice might be given to terminate it. If no such notice were given, the treaty remains in force from year to year. What he looked to, was not only that the colonial Article should provide that the self-governing colonies should have the right of determining whether or not they would accede to the treaty, but that when the period for termination arrived, they should also have the right to say whether or not they would continue to adhere to it.

Mr. NIVEN asked how this arrangement would work with regard to such a problem as occurred in Australia with regard to Chinese immigration.

Sir CHARLES KENNEDY said the responsible government of the colony would have to place before the Home Government their views on the matter, stating that unless they were agreed to, the colony would be compelled to withdraw from the treaty at the date when it is terminable.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 13, 1895; SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Adams, Henry James, 13, Salcott-road, Wandsworth-common, S.W.

Bell, Joseph, Messrs. Barlow and Jones, Limited, 2, Portland-street, Manchester.

Williams, Llewellyn, Coolgardie, West Australia, and Cardiff Castle Gold Mines, Limited, 1, Queen Victoria-street, E.C.

The following candidates were ballotted for and duly elected members of the Society.

Dawson, James Henry, The Grange, Tilford, Farnham, Surrey.

Peers, George Robinson, 34, Memorial-road, Walkden, near Bolton.

Reynolds, Alleyne, Bolsover-hill, Sheffield.

The paper read was—

THE MEAT SUPPLY OF THE UNITED KINGDOM.

By E. MONTAGUE NELSON.

The subject of this paper is one of importance to every individual in the country, but comparatively few are interested in the sources and methods of supply. I will endeavour not to weary my hearers with a confusing mass of figures, and with that object in view I have had printed at the end of the paper a Table of various statistics, which those specially interested in the subject may find useful.

About twenty-five years ago, the subject of food supply began to attract attention, as it was apparent the United Kingdom could not grow enough meat to feed her own population, which then stood at 31,600,000, and the number of stock at 10,000,000 cattle and 34,000,000 sheep (*see* appendix).

The records of the *Journal* of the Society of Arts, published as early as 1867, show that a committee was then appointed to "inquire and report respecting the food of the people especially, but not exclusively, the working-classes of the people." This committee continued its meetings until 1870, without arriving at any very definite conclusion as to the best means of importing meat from foreign countries, various experiments having been tested of salting, canning, and preparations of "dessicated meat" from Queensland. In their final report, published in 1870, they state that "notwithstanding the excellent quality of meat cured at Deptford for the use of the Royal Navy, the committee considered the American specimens so specially good as even to exceed in value the British sample."

But in the *Journal* of this Society of June 26th, 1868, the following interesting paragraph appears in connection with the importation of meat from abroad:—

"For this purpose it has been proposed by influential persons at Sydney to resort to a different

instrumentality—that of cold. They assert that when the meat is placed in a closed vessel, the temperature of which is reduced from without, none of the bad effects follow which are said to arise when provisions are frozen by actual contact with ice. At present the promoters of this plan are understood not to have decided in what form they can most economically provide the refrigeration, which must of course be kept up during the voyage by some artificial means, and no meat has as yet arrived in this country preserved by this process. The committee look with interest at the scheme, and hope to hear of some practical trial of it which may determine its value. In connection with this plan they desire to record their satisfaction at the energetic manner in which the subject generally has been taken up iu Australia."

This is a very correct forecast of what was carried out on a commercial scale 12 years later on. At the time this committee terminated its investigations America had not only taken the lead in the supply of all kinds of preserved animal food, but was also exporting to the United Kingdom a large quantity of live stock. A further developement was also taking place in the direction of fresh meat which now began to arrive from the States in the form of chilled beef. This trade has expanded from 36,000 cwt. in 1872 to nearly 2,000,000 cwt. in 1894, and exercises a very important influence on the markets here. This influence brought to bear upon the meat market of London by a foreign country is one which it is not wise to entirely overlook. It will be in the recollection of you all that in the early part of last year a labour conflict was raging in Chicago which many thought might easily assume the proportions of a civil war. If that had been the case and the American supply had been withdrawn from the home markets, the consequences must have been severely felt by consumers, especially among the poorer classes.

It was not until 1880 that our Australasian colonies commenced to be a factor in the great question of supply, and the inception of the frozen meat trade is of sufficient interest to warrant a description of the pioneer shipments.

Early in 1880, the first shipment of frozen meat was made from Australia by Messrs. McIlwraith, McEacharn and Co. from Melbourne in the ss. *Strathleven*, when 400 sheep were frozen and sent to London. The success of this experiment, followed by the *Protos* with 1,900 sheep and lambs soon after, caused the New Zealand and Australian Land Company to make arrangements for a trial upon a large scale, and the sailing ship *Dunedin* was fitted out in Glasgow, and sailed thence on 23rd August, 1881, with machinery specially designed and fitted under the management of Mr. Coleman, assisted by his partner Mr. Bell. There being no freezing establishment then in New Zealand, the ship had to be a combined freezer and carrier; this Mr. Coleman managed by having separate chambers for freezing and storage; and now everything was ready for the first trial from New Zealand upon a large scale, 5,000 sheep being the number determined upon for shipment. It was found upon arrival at Port Chalmers that the *Dunedin* was equal to her work, and there was no difficulty in freezing the sheep on board. All the operations were personally superintended by Mr. W. S. Davidson, general manager of the company, and Mr. Brydone, manager in New Zealand.

Trouble, however, began when the vessel was becalmed in the tropics, and the temperature was gradually found to be rising in the 'tween decks, in spite of every effort on the part of the engineers to keep it below freezing point.

"The hour brings the man," and this time the man turned up in Captain Whitson in command of the ship, who proved himself worthy of the grateful thanks which he afterwards received from all concerned in the venture, for had he not been a man with ample courage and resource there would have been, at any rate, a partially injured cargo to deal with in London. The main air trunk had got snowed up, and the captain himself crawled down to clear it out, and was successful, but got so benumbed during the process that he had to be hauled out by the heels with a rope. Captain Whitson's lot was not a happy one during this voyage as, in addition to the anxiety of maintaining cold below deck, he was on certain tacks of the ship in constant dread of setting his sails and rigging on fire by sparks from the refrigerating engine funnel. However, in the end, all difficulties were overcome, and after his strangely-equipped craft had received much attention in the Channel from passing steamers, which offered towing assistance to what they could only imagine was a disabled steamer, he landed his cargo in splendid order. The mutton was sold at an average of over 6d. per pound, and thus began a new industry, which is now such an important factor in the food supply of the United Kingdom. Since that time freezing works have been erected in all parts of New Zealand, and the output has steadily in-

creased, until it has reached nearly 2,000,000 sheep and lambs per annum.

Although Australia was the first in the field, yet, from various causes, the trade was allowed to decline, and it is only within the last four or five years that it has been vigorously prosecuted, the import for the last year having reached close on 1,000,000 carcases.

The Argentine Republic started freezing operations in 1883, and has steadily increased her export, shipping, in 1894, nearly 1,400,000 carcases.

From the commencement of the trade we have received from all sources 26,000,000 sheep and lambs, of which New Zealand has supplied half, Australia 3,000,000, the River Plate 9,000,000, and Falkland Islands 150,000.

In connection with this part of my subject I will quote figures from the Inspector of Stock for the Colony of New South Wales, who, last year, visited America and Europe to report to his Government upon the frozen meat trade in the Colonies and Great Britain. It appears, from his calculation, that there are, in round numbers, about 300,000,000 sheep in the various countries which find a market for their surplus mutton in the British Isles. Of these, about one-half are in our own colonies, and the rest in foreign countries. These sheep are of all descriptions, and at present only 85,000,000 are cross-breds. Mr. Bruce thinks, however, that in five years this number will have increased to 120,000,000. Should such be the case, and 10 per cent. of these flocks sent to the United Kingdom, which is the proportion now coming from New Zealand, we should get an import of 12,000,000 carcases a year, or about equal to the number of sheep assumed to be slaughtered annually in this country. It is evident that now Australasian and Argentine pastoralists are following the example of New Zealand, and devoting their attention to the carcase as well as the wool, the pressure of surplus stock upon the English markets must be very severe. The problem of the future would thus appear to be not how can Great Britain provide her necessary meat supply, but how much can she absorb at a price which will allow the import trade to expand. I will here refer to the condition under which it is conducted in respect to Australasia.

In the early stages of the business, freight from Australia was 2½d. per lb., and owing to competition it is now about 1d. per lb., and sometimes even less, and ships can make fair earnings when prices at this end warrant large shipments. Freights for frozen produce must necessarily be expensive owing to the cost of fitting up the ships with the necessary machinery and insulation, which takes up a considerable amount of room, and reduce the carrying capacity of the hold.

There are now over 80 ships engaged in the trade, with a carrying capacity of about 2,500,000 carcases, and making two voyages a year on the average—some of them being able to stow as many as 90,000 carcases—and the business has reached such a state of perfection that accidents rarely occur. As a proof of this, marine insurance covering damage arising from any cause is now reduced to under £3 3s. per cent.

In order to furnish accommodation for such large supplies of frozen meat, and to properly distribute it here, it has been found necessary to provide storage which, already available and in course of erection, is sufficient for 900,000 sheep or an equivalent of beef.

The meat is placed upon the market in a frozen state, and one of the great difficulties in the way of selling and making a fair price is the wet appearance it always assumes in the butcher's shop, more particularly in warm weather. This is caused by the condensation of moisture from the atmosphere on the frozen surface of the meat, and seriously affects the selling value. For some time past experiments have been made in thawing or "defrosting" this meat, and have recently been brought to a successful issue. The process of thawing is obviously the reverse of freezing; and as the latter is accomplished by attacking the meat with cold, dry air, the former is done by hot, dry air. When properly carried out, the meat presents the same appearance as before being frozen. This natural process of defrosting is expected to prove of great value in the development of the frozen beef trade, which has to make its way in face of the enormous shipments of chilled beef from America. Queensland, in particular, has boundless resources for the supply of the home market, and is making considerable progress with her shipments. Taking into account the fact that the cost of cattle there is only about one-fifth of what it is in some parts of the United States, and that her population is insignificant compared with the, say, 70,000,000 of the latter, it is only reasonable to conclude that the colony, in spite of her greater distance, will gradually but surely supplant America in the market here.

In respect to quality our home-grown beef and mutton cannot be surpassed in any country in the world. The pasture lands are excellent and the best results are obtained from animals fed more upon natural than artificial food. In many parts of New Zealand we get similar climatic conditions and equally excellent mutton is produced. In the United States and Canada the winters are very severe and all kinds of stock require artificial feeding for several months; but in Australia nature is most bountiful, and there being practically no winter, stock of every description thrives well all the year round upon the natural grass and herbage. It is a curious fact that whenever rain falls, more particularly in Queensland, there is an immediate growth of grass in summer and herbs in the winter months, both equally good for fattening stock. The meat produced from these pastures is of first-class quality and second only to our best home-grown, although as yet it does not command nearly so high a price in the market.

Experiments are now being made in respect to the shipment of live cattle from Australia, and the trials already completed are sufficient to prove that they can be carried the long sea voyage without loss of condition. It is therefore probable that a large trade may be conducted in this way provided it can be profitably worked.

Before leaving this part of my subject it might be interesting to give a short account of the general working of a freezing establishment. The principal establishments in New Zealand are those of Napier and Wellington in the North Island, and Christchurch, Dunedin, and Bluff in the South Island, while in Australia we have the largest establishment of the kind at Rockhampton, and other extensive works at Brisbane, Townsville, Aberdeen, &c.

The freezing works at Tomoana are a block of buildings covering between two and three acres. The large receiving and drafting yard for sheep and cattle are complete with all the necessary races and pens. Here the stock for killing are received, tallied, and drafted, nothing being driven into the slaughter-house which shows signs of being unfit for killing.

From the yards we enter the slaughter-house. In this building all the floors are of concrete, enabling the place to be kept thoroughly cool, fresh, and clean by continual flushings with water. Here we meet with a sight not easily to be forgotten. With room for thirty-two butchers working in a long line, as many as 2,000 sheep a day are killed in the busiest part of the season. From the slaughter-house a series of overhead rails provide a distinct rail for each butcher, on which the sheep he kills travel on rollers towards the cooling-room. The sheep are received at the opening into the cooling-room by the dressers, who adjust the sets and tie-backs and put the finishing touches on the carcase. Each one is then weighed and ticketed, the ticket showing the brand of the particular "lot" of sheep, and the weight of the carcase. At this point the sheep are graded in accordance with their weight and quality, the carcases being individually examined by an expert, who either passes them as fit to ship, or rejects them for blemishes, bad colour, poor condition, excessive fatness, or a variety of other causes. Greatest care is exercised in this department, no old ewes, or any sheep weighing over 70 pounds being passed for shipment. The cooling-room is fitted with cold brine pipes carried overhead; these maintain a medium temperature even in the hottest weather, and create a current of air which precludes the slightest possibility of bone-taint or other damage.

After the sheep have been thoroughly cooled they are taken to the freezing-room in the upper storey (of which there are four, capable of freezing 2,000 sheep each), by means of elevating machines on the principle of an endless chain. The sheep hanging on these are thus transported to any part of the freezing chamber that may be required, and here they hang until thoroughly frozen, when, having been put into their bags, they are passed through shoots in the floor to the store rooms below, which have a capacity of nearly 100,000 sheep. The bags are branded with marks indicating both the grade and the particular "lot" to which each sheep belongs. The engine-room is well worthy of attention, containing, as it does, three of Haslam's largest cold air refrigerators, each delivering 170,000 cubic feet per hour, at a temperature of 70° below zero, and a complete carbonic anhydride machine, with circulating pipes. Various other electrical and pumping plant make up a very complete establishment. Here, as elsewhere in the works, cleanliness is very noticeable, the floor being in quarter-deck condition. Steam is supplied by six Babcock and Wilson boilers, producing 800 horse-power.

A very important and valuable feature of the works is the wonderful water supply from artesian wells. There are some dozens of

these, the pipes varying from two to six inches, the largest, a six-inch well, some 150 feet deep, throwing as much as 15,000 gallons per hour.

The other departments of the industry are very important, comprising the treatment of all the by-products of the carcase. The best fat is converted into oleo and stearine. The other fat and offal are converted into tallow and manure respectively, whilst the skins are fell-mongered and the wool removed to the wool-sheds for treatment. The meat preserving department, which is very extensive, includes the tinning of beef, mutton, tongues, &c.

So far, I have dealt chiefly with meat imported in a fresh state, namely, alive, chilled, and frozen; in addition, large quantities are received, chiefly from the United States and Canada, smoked, tinned, and in the form of extracts of various kinds. Comparing the cost of production of the live animal in America with Australasia, it seems strange that the colonies are not competing more briskly for this branch of supply. As already mentioned, a prime beast in the United States is almost as valuable as a prime beast in England, and five times more valuable than one in Queensland, and yet we find importations of preserved meats from the States by far the largest. It would appear, therefore, that the colonists have much to learn in this branch of the business, and there can be no doubt a greater attention to details, and the disposal of by-products would result in much better returns being obtained for animals not quite prime enough for freezing.

Having now referred to the various sources of supply, I will conclude this paper with a few words as to the general consumption of meat in this country.

Taking into account all descriptions, both fresh and preserved, the total amounts to 2,140,000 tons; about two-thirds of the quantity is home-grown and one-third imported. It is a matter of importance to note, the latter having doubled within the last ten years. The figures in the Tables annexed show that the consumption of meat is rapidly increasing: but, in order to deal with the probable increase of colonial imports, during the next few years, it will be necessary to attend more to distribution at this end. Fresh outlets will require to be established at various ports, as already London is supplied with as much as it can consume. It is computed that, in addition to the supplies of live stock to the Metropolitan markets, Smithfield alone provides in a year 130 lbs. of meat for every man, woman, and child within fifteen miles of Charing-cross, or, in other words, a weekly consumption of 14 lbs. for every family. Some of this meat, however, finds its way further afield. Of the above, about 25 lbs. would be American beef, and nearly 20 lbs. per head Australasian mutton and beef. If every family in greater London purchased one more joint of frozen mutton or lamb in a year, it would mean an additional sale of 500,000 carcases at Smithfield, and as the consumption of the wage-earning classes is a good deal regulated by the state of trade generally, we can understand from this the effect of trade depression upon the meat market.

It is difficult to give an opinion upon the question of prices, fluctuations being very rapid, almost unaccountable and quite beyond control. The weather and trade conditions, as already mentioned, interfering with demand, whilst irregular shipments, droughts, floods, &c., at the other end, interfere equally with supply; but with other ports of call, no doubt in a few years we may look for more uniform prices than have obtained in the past. Our colonies cannot consume their surplus, and must get rid of it by attacking the existing channels of supply, so that the result will probably be a continuation of the present uncertainty in values until the trade settles itself in the usual way. In the end it seems reasonable to suppose that the countries where the raw material is most cheaply produced will reap the greatest benefit, as in these days of rapid steam communication distance is of little importance.

You will remember that in the early part of this paper I mentioned that the first shipment of New Zealand mutton realised over 6d. per pound. In 1889, the average price obtained was 4⅝d.; that price has gradually fallen year by year until, for 1894, the average was only 3¾d. During these years the wholesale prices of English and Scotch mutton have varied from about 7d. to 7½d. per pound, so that at the present time the home-grown article is realising exactly double the price of New Zealand. It cannot, therefore, be said with any truth that these imports have done injury to the British farmer. There is no doubt that he has suffered very considerably in many ways, and his condition is being continually discussed with much sympathy all over the country, but I would venture to assert that the British farmer is entitled to equal consideration whether he happens to reside in New Zealand and Australia, or in Kent and Sussex.

This is not the place for political discussion, but if any legislation takes place with regard to the commercial federation of the empire, which is much to be desired, I think you will agree with me that it would be preferable for this trade to be, as far as possible, in the hands of our colonies, rather than foreign countries.

Looking at the vast areas of production, and the enterprise already displayed, the consumer may rest assured that so long as England maintains her maritime supremacy there will be no failure in the supply of cheap and excellent food brought to his door; on the other hand, any prolonged check of imports would be immediately and severely felt, especially by our great urban populations.

APPENDIX I.—POPULATION AND STOCK OF LIVE SHEEP AND CATTLE.

United Kingdom.

	Population.	Sheep.	Cattle.
1873	32,177,550	33,982,000	10,154,000
1883	35,449,411	28,348,000	10,098,000
1887	36,599,143	29,401,750	10,639,960
1888	36,881,271	28,938,716	10,268,600
1889	37,178,929	29,484,774	10,272,765
1890	37,484,764	31,667,195	10,789,858
1891	37,797,013	33,534,000	11,343,686
1892	38,106,675	33,642,808	11,519,417
1893	38,440,249	31,775,824	11,207,554

U.S. America.

1874	50,155,783	35,192,074	35,925,511
1887	—	44,759,314	48,033,833
1888	—	43,544,755	49,234,777
1889	—	42,599,079	50,332,042
1890	62,622,250	44,836,072	52,801,907
1891	—	43,431,136	52,895,239
1892	—	44,938,365	54,067,590
1893	—	47,273,533	52,378,263

Australasia.

1871	1,924,770	—	—
1881	2,742,550	97,239,986	8,873,574
1890	—	114,081,069	10,978,039
1891	3,809,895	124,193,261	11,550,545
1892	—	122,572,345	12,159,309

Argentine Republic.

1893....	4,531,000	—	—
1894....	—	80,00,0000	22,000,000

DISCUSSION.

The CHAIRMAN said he was quite sure that everyone would agree that Mr. Nelson had given information of the most precise character upon a subject which, perhaps, of all others was of the most practical importance—the subject of food. He had shown how within some 20 years there had been an enormous increase in the importation of meat, and how this had been due to the endeavours of persons in the colonies to send here that which to them was surplus stock. He felt in a very great difficulty in this matter as, on the one hand, all must rejoice to find that every person in England had three times the quantity of imported meat he had 20 years ago, while, on the other hand, they could not help deploring, when travelling about the country, to see the number of derelict farms which no one would take, as they could not be worked at a profit. They could only trust that when things were left to themselves, and were not meddled with by Government, that in time they would balance themselves and find their own proper level. He was quite certain that they could not have found anybody to read a paper upon this particular subject better qualified than Mr. Nelson, and he would now ask the meeting to discuss it.

Sir WESTBY PERCEVAL K.C.M.G., said he had little to add by way of criticism to the paper, because it had been chiefly a record of the history of the trade, and as such was extremely valuable. He hoped the paper would be very widely circulated, because he felt sure it would do immense benefit to the colonial trade. What they suffered most from was the fact that the quality of the meat was not sufficiently recognised in this country. Those who had watched the progress of the trade had noticed, to their regret, the very great prejudice which existed amongst the working classes of the country to what was called "dead meat," a term which he disliked very much. Undoubtedly, the prejudice did exist, and it was only being gradually overcome. The chief reason for this prejudice was the unsightly condition in which the meat was presented to the market, and he looked forward with great hopes to the new discovery of defrosting, by which means the meat would be sent out in a dry condition. He had had a joint of meat served upon his table which, when a knife was put into it, was absolutely raw in the centre, the cause no doubt being that the meat was sent in a frozen block to the butcher who had not thawed it before sending it out. If greater care were exercised on this head the trade would benefit considerably. He hoped Mr. Nelson would endeavour to foster that defrosting process, as

APPENDIX II.

Year.	Live Sheep.	Live Cattle.	American Chilled Beef.	Australasian frozen Mutton.	Australasian frozen Beef.	River Plate. Mutton.	River Plate. Beef.	Total Dead Meat Imported. Fresh and Preserved.	Value.	Proportion per Head of Population Imported.
			cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	£	lbs.
1872......	810,000	173,000	36,000	...	...	...	...	2,845,909	...	10
1882......	1,124,000	344,000	724,272	29,506*	138	...	...	4,652,281	...	14·8
1883......	1,116,115	474,750	730,796	82,422*	1,719	6,130	...	6,045,390	...	19·1
1884......	945,042	425,507	811,644	233,990*	4,775	38,867	...	5,805,113	...	18·2
1885......	750,886	373,078	854,845	268,196*	18,048	68,061	...	6,688,500	...	20·8
1886......	1,038,965	319,622	762,226	384,176	21,117	190,409	6,736	6,711,389	...	20·7
1887......	971,404	295,961	643,320	441,289	8,416	251,273	270	6,568,077	...	20·1
1888......	956,210	377,088	784,429	543,117	41,354	353,482	3,678	6,734,493	14,969,850	20·4
1889......	677,958	555,222	1,275,943	613,471	100,023	394,979	8,665	8,468,653	18,257,443	25·5
1890......	358,458	642,596	1,693,148	897,148	109,831	435,187	8,933	9,924,549	20,224,653	29·6
1891......	344,504	507,407	1,747,578	1,063,326	149,048	436,358	14,485	9,790,210	19,860,895	29
1892......	379,048	502,287	1,951,817	968,824	119,694	471,128	8,309	10,500,042	22,055,808	30·9
1893......	62,682	340,845	1,489,949	1,187,458	225,689	515,611	35,383	8,759,283	20,898,733	...
1894......	484,764	476,057	1,775,528	1,439,502	304,513	585,728	5,279	...	...	...

* Estimated.

the unsightly appearance was one of the chief drawbacks of the trade. Although the future prospects of the trade, from a colonial point of view, were none too hopeful, as prices were low, he had no fear as to ultimate success. The meat only required to be more known and to be more carefully prepared and marketed to grow in popular estimation. It might not be a bright outlook for the British farmer, but the British farmer in whatever part of the world he was working was entitled to consideration, and he felt sure that people in this country would not object to see farmers in the colony prospering for the good of the empire as a whole, notwithstanding that the farming industry in this country might to some extent suffer.

Sir William White, K.C.B., F.R.S., was not aware that his own line of work in any way gave him the right to join in a discussion as to meat, either alive or dead, but he might remark that about two years ago he had the pleasure, under the personal guidance of Mr. Harris, of visiting the great storage warehouse of which Mr. Nelson was the head, and he there saw most of the mechanical details to the arrangement of which the success of their great business owed so much. He visited the work on a summer day, the temperature being about 90° in the shade, but in the storage warehouse it was 20° Fahr. He was particularly struck with the complete and perfect details for dealing with the carcases, of which he saw many very well preserved. From their arrival at the foot of the endless chain which took them to the upper floor, the carcases were handled with the minimum of manual labour, and the whole place was beautifully clean. He considered that defrosting would have a marked effect on the favour with which the public would look upon frozen meat. He had not consciously any large experience in the consumption of Australian meat, as he was supposed to be supplied with British meat; but he had no doubt that many of the joints which were supplied as prime British came from the colonies. On the occasion to which he referred he enjoyed an excellent lunch, at which all the parts were avowedly imported, and the only item to which he could at all take exception was that of a New Zealand fish, not on account of its preservation, but because he thought it must have been a very poor kind of fish to start with. One feature in which he took great interest was the enormous reduction of freightage. Mr. Nelson had stated that, in the early stages, the freight was 2½d. per lb., but owing to competition, it was now 1d. per lb.; but to his mind there were other circumstances besides competition which had a great deal to do with lowering the freight. For instance, there had been enormous economy in coal consumption caused by improvements in marine engineering, and, again, the reduction in the power expended in propulsion. Ships had also been made of greater size, and, by well-known laws, the expense of carrying dead weight was proportionately lower. He would take the case of a ship having about 5,000 tons of dead weight carrying power, with from 1,000 to 1,200

horse-power; this ship would probably average from nine to ten knots all the way, and would now come from Australia in fifty days, burning less than 1,000 tons of coal, at an expense of about £500. These were startling figures, but they were perfectly correct. Whether the British farmer would rise to that height of patriotism which had been suggested he could not say, but there was a great amount of force in the remarks of the reader of the paper as to the advantage of treating the Empire as a whole when dealing with commercial and industrial subjects.

Mr. F. H. Dangar said the importation of Australian meat was not to him at all a new matter, as his father, in 1847, commenced the preservation of meat in tins, a large quantity of which came to London. The price of cattle at that time in Australia was from £2 to £4 per head, but owing to the gold discovery, in 1851, the price rose from £8 to £10, which of course at once put an end to the industry. Salted meat had also been sent from Australia. Last month twenty-seven live bullocks were sent from Sydney to London, two died on the way from injuries received at sea, but the remainder were landed in splendid condition, and realised about £21 per head. The cost of freight was £6 per head, and the net return about £8 per head, whereas if they had been sold in Sydney they would not have realised more than £4 per head. The cattle imported from the River Plate were very much inferior to those from Australia. Some black Scotch cattle were also shipped at the same time as those to which he had referred, but the experiment had not been a success, owing to the dead weight being too great, namely, 1,600 lbs. The proper weight to send to Smithfield was from 800 lbs. to 850 lbs., and the age should be about $3\frac{1}{2}$ years. He knew a case where a large property, with 13,000 head of cattle, had lately been sold in Australia for £12,000, so that anyone could see what a fine return might be obtained by investing money in this manner. He felt sure, as time rolled on, they would find that Australia would be able to supply England, not only with frozen meat, but with live cattle. A great mistake had been made in getting chilled meat from Australia, by employing steamers not suited to the purpose, but arrangements were now in course of being carried out which would remedy this mistake; and he felt confident that meat would soon be landed here in a properly chilled condition.

The Chairman said Mr. Nelson had not told them of his own personal work, that is to say, the work which intervened between the reception in England of the frozen meat in the ship, and the time when it was delivered to the consumer; and as no doubt the meeting would be glad to have some information on this point, he would ask Mr. Harris to state the process pursued in preserving the meat from the time it reached London until it got to Smithfield.

Mr. H. Graham Harris said the dealing with the meat, after it arrived in London, was a very simple matter. It had only to be stored and maintained at a low temperature. Much that had been done as regards the storing of the meat in London was due to Mr. Nelson. The engineer was only the implement with which the intelligent commercial man dealt. The engineer's greatest difficulty was to find a client who believed in him. Mr. Nelson believed in him (Mr. Harris), and between them they had made a fair success. They had upon the other side of the river, close to Blackfriars-bridge, a large cold meat storage place; the meat was taken from the ship, delivered into barges battened down, brought up the river to the store, and there lifted by endless chains on to the top floor of what was practically a brick box with wood insulation some 40 ft. deep and 150 ft. square. The carcases were dropped from a hole in the top floor down the six floors which divided the space between the top floor and the basement. The place was kept cold by means of two ammonia compression machines, manufactured by Sterne and Company, of Glasgow. The meat was stored as long as was necessary, and was then again taken through the hatchway in the top, delivered into carts and taken to the market where it was sold. The engineering part of the business had been an extremely simple one, but had he not been helped by Mr. Nelson in dealing with the meat as meat, the success which had arisen would not have been achieved. He supposed that that which was true of the way of dealing with the meat at this end was, to a large extent, true of the way of dealing with it at the other end, the process there had merely to be reversed. One of the greatest difficulties was that of making the meat sightly after it left the cold store, and it was in this direction that Mr. Nelson had done the very best work. The process of defrosting had been arrived at after a long series of experiments, and was entirely due to Mr. Nelson. This process had the commercial advantage of putting about 20 per cent. on the value of the meat. The time during which the meat was frozen might be taken as nothing, and after defrosting it might be kept for three days.

Mr. H. Moncrieff Paul agreed that the paper was not one for criticism though it was exceedingly useful, and his remarks would be rather in the direction of supplementing to a certain extent what had fallen from Mr. Nelson. The works at Blackfriars were not the only storage places; there were large cold-storage places at the docks, and in other places. The development of the trade had been such that at certain periods of the year the storage accommodation was not sufficient to meet the demands made upon it. The prejudice against frozen meat largely rested with the cooks at the West End, who would not have anything to do with what was cheap. It was an open secret that there was a certain amount of

freemasonry between butchers and cooks, and directly servants were informed that anything was cheap they were up in arms against it. If the meat had been sold on its merits, without any reference to its origin, a great advantage would have accrued to the industry. He thought the defrosting process would have a most beneficial effect upon the trade. As to importing cattle alive from Australia, he thought this was not the easy matter Mr. Dangar rather led them to believe, as in dealing with large herds it would be found somewhat difficult to keep them quiet and to properly feed them on the voyage. No doubt the cattle Mr. Dangar had referred to were well-bred cattle, but one could not generalise from that particular shipment. With regard to the age of cattle, he thought that in Smithfield they were accustomed tò young meat; in fact, they were eating as beef what their grandfathers would never have called beef. Then, as to distribution, he considered that a great deal might be done which had not yet been done. Persons interested in the Manchester Ship Canal thought that as soon as it was opened there would be an inflow of frozen meat into Manchester, but a great many things would have to be done before this came about. As to chilled beef, he agreed that something practical might be done in this direction. They really had three strings to their bow, chilled meat, frozen meat, and live cattle. Initial experiments were always open to a certain amount of want of success, just as everyone knew that the pioneer was not the man who made the money. A large proportion of sheep in Australia were merino, which were not so well adapted to the requirements of the trade as cross-bred sheep. Mr. Nelson had very properly alluded to the fact that by-products were not so well attended to in Australian colonies as in the United States; but this would be remedied in the course of time, in fact, the colonists were now endeavouring to utilise the by-products to a greater extent than had hitherto been done.

Sir James Garrick, K.C.M.G. (Agent-General for Queensland) did not know that there was much more to be said on the subject, after hearing the paper and the various speeches of the previous speakers; but he might be permitted to bear testimony to Mr. Nelson's experience in all branches of the industry. He had some sympathy with the British farmer, who was subjected to the severest competition on the part of all new countries where land was of no value, and where the climatic conditions were greatly different from those of England; but he was inclined to think that Queensland, in sending beef to this country, did not interfere with the British farmer. Queensland had rather expanded the area of consumption by the importation of beef, and had opened up markets which hitherto did not exist for the consumption of meat; and they were supplying those consumers in the expanded area, leaving still for the sole occupation of the British farmer the area which he already possessed. It was said that the British farmer should look upon the colonial farmer as a British farmer, and it was very easy to say this, but it was very difficult to fairly argue it and to realise it, for England had a fiscal system which permitted the severest competition by all other countries which had better advantages for supply. He did not wish to trespass on political grounds, but he had his own way of thinking, that they were being driven to a consideration of the federal commercial action which had been lightly referred to, and when that question came to be considered, the meat supply would only be one of many which would have to be considered. The import of Queensland beef into England was about one per cent. of the foreign meat consumed here, the other 99 per cent. coming exclusively from foreign countries. The United States of America sent an enormous quantity of chilled meat to this country, and this they were able to do owing to the short sea voyage, but in Queensland the meat had to be frozen before it could be shipped. If science could devise the means for bringing the meat alive from Queensland, he had no doubt that triumph would rest with the country which possessed natural advantages for raising cattle. He was glad to learn that the defrosting process had been a success, believing that it would be of the greatest advantage to the colony which he had the honour to represent.

Mr. J. J. Thomson said a good deal had been stated as to the advantages which Australia possessed over the United States as a producing country, and all these advantages he admitted, but the last speaker had touched the vital question—that cattle could not be sent in a chilled state. If Australia could devise some means of bringing meat over in a chilled state, America would have to look out for itself.

Mr. Oscar de Satgé thought that Sir Westby Perceval, in alluding to the frozen meat trade, ought to have spoken more enthusiastically of a trade which had saved his colony from ruin. New Zealand meat had now made a market for itself, second only to that of Scotch or Southdown mutton. Whether New Zealand managed to get the proper blend of cross-bred sheep or not he did not know, but they had secured a species which had arrived in this country in splendid condition. The merino sheep was a leaner animal and could not compare with a cross-bred sheep, but it could be bred so cheaply as to afford an article of food for the poorer classes that could not be competed with by any country in the world. England could look forward to a future importation of the cheapest possible article of meat. He regretted that Mr. Nelson had not referred to the means of distribution among the masses. His own opinion was that they had not yet arrived at a proper means of distribution, as the meat was not put within the reach of the poorer classes. As a bullock in Chicago cost from £12 to £15, he thought it would be a long time

efore America could compete with Queensland. As ie defrosting process would open up a great future or the colony, he should be glad to know whether he beef after being thawed was equal to the chilled eef of America. He was glad to learn that the onsumption of meat had largely increased in England during the last few years, and what they ad now to do was to cheapen food so as to increase ts consumption throughout Great Britain.

Mr. G. Beetham, on behalf of the farmers of New Zealand, begged to thank Mr. Nelson for his efforts to enable them to dispose of their surplus stock. He thought the reader of the paper had missed one good point, which was this, that physiologists stated that the nations which eat the most meat were always victorious in international wars.

Mr. Nelson, in reply, said it had been rightly said by two or three speakers that there was not very much to criticise in the paper, for it was simply a statement of facts, showing how the trade had progressed during the last 25 years. No doubt the reduction in the cost of freightage was due to increased size of the ships and to reduced consumption of coal. At one time 10,000 carcases was considered a fair load, but now 90,000 to 100,000 were carried. He hoped Mr. Paul did not think he was appropriating too much to the company which he represented; but as to storage, he had mentioned that there was capacity for 900,000 carcases, and it could hardly be supposed he suggested that was all supplied by Nelson Bros. As regards the distribution of the meat by retailers to the poorer classes, he might say that there was no subject upon which there was a greater difference of opinion among experts; many people who came from the colonies thought that shops should be opened for the sale of the meat, but it seemed to be forgotten that a butcher's shop could not be run on mutton alone. It would be necessary to buy double the amount of beef to carry on a butcher's business. There were plenty of shops in the country, and only that afternoon he had seen a butcher who had shops at Lichfield, Burnley, and other places, in which he sold 500 sheep each week, receiving for legs 4d. per pound. No one connected with the colonies could do much better than that. They were all agreed that the nations which consumed the most meat were generally victorious in battle, and statistics proved that Englishmen eat more meat than any other nation. England had been victorious in the past, and he hoped she always would be in the future.

The Chairman, in proposing a hearty vote of thanks to Mr. Nelson, referred to the fact that beef, such as he could remember as common in his younger days, could not now be obtained. He had no doubt that, in the interest of all people, it was well that beef of a less admirable quality should be produced in very large quantities, but he could not help deploring the friend of his youth. He had heard of four-year-old mutton, but he thought beef and mutton were now too often provided by calves and lambs of immature age. As we go on quickening everything, he supposed this could not be helped.

The vote of thanks having been unanimously passed, the meeting adjourned.

General Notes.

Cotton States and International Exhibition.—It is proposed to hold an International Exhibition at Atlanta, Georgia, U.S.A., specially for the Cotton States. The Exhibition is to be opened on the 18th September next, and to close on the 31st December. The classification is quite comprehensive, and includes the usual departments of International Exhibitions, the following being the divisions:—Minerals and Forestry; Agriculture, Food and its accessories, Machinery and Appliances; Horticulture, Viticulture, Pomology, Floriculture, &c.; Machinery; Manufactures; Electricity and electrical appliances; Fine Arts, Painting, Sculpture, and Decoration; Liberal Arts, Education, Literature, Music, and the Drama; Live Stock, Domestic and Wild Animals, Fish, Fisheries, and Fish Culture; Transportation. The United States Government have given permission for exhibits to be brought in free of Customs' duties, unless the goods are entered for consumption in the States. Exhibits are invited from foreign countries on the usual conditions. Further information may be obtained from the Director-General, Mr. C. A. Collier, Piedmont-park, Atlanta, Georgia, U.S.A. Copies of the classification and general regulations have been sent to the Secretary of the Society of Arts, and can be seen at the Society's offices by any persons interested.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock:—

March 20.—"The Progress of the Abattoir System in England." By H. F. Lester, Hon. Secretary to the London Model Abattoir Society. Sir Benjamin W. Richardson, M.D., F.R.S., will preside.

March 27.—"Modern Photogravure Methods." By Horace Wilmer.

Indian Section.

Thursday Afternoons, at Half-past Four o'clock:—

March 28.—"Chitral and the States of the Hindu

Kush." By Capt. F. E. Younghusband, C.I.E. The Hon. George Curzon, M.P., will preside.

Applied Art Section.

Tuesday Evenings, at Eight o'clock :—

March 19.—"Practical Carpet Designing." By Alexander Millar. J. Hungerford Pollen will preside.

Cantor Lectures.

Monday Evenings, at Eight o'clock :—

Dr. D. Morris, C.M.G., "Commercial Fibres." Three Lectures.

March 18.—Lecture I.—Cellulose and non-cellulose constituents of fibres—Chemical tests for cellulose—Comparative estimation of fibres—Pure cellulose in cotton, kapok, vegetable silks, and seed-hairs—Bast fibres of dicotyledonous plants—Fibre - bundles and ultimate fibre - cells—Higher textile fibres: Flax — Hemp — Calotropis — Sunn-hemp — Marsdenia — Sida — Nettle fibres: China-grass — Rhea—Nilgiri nettle — Pua-hemp — Ban-rhea—Urera—Lower textile fibres: Indian jute—Chinese jute—American jute—Abroma—Abutilon fibres—Deccan hemp—Roselle fibre—Ban-ochra—Helicteres—Pavonia and malvaviscus fibres.

MEETINGS FOR THE ENSUING WEEK.

Monday, Mar. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. (Cantor Lectures.) Dr. D. Morris, "Commercial Fibres." (Lecture I.)

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. Lyonel Clarke, "Photography as an Instantaneous Recorder."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. E. M. Leman, "Agricultural Credit Banks."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m.

Tuesday, March 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Alexander Millar, "Practical Carpet Designing."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "Internal Framework of Plants and Animals." (Lecture X.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on Mr. William Duff Bruce's paper on "The Kidderpur Docks, Calcutta," and Mr. James Henry Apjohn's "Note on the Movement of the Walls of the Kidderpur Docks." 2. Mr. Henry Davey, "Steam-engine Economy: Condensing Engines."

Statistical, Geological Museum, Jermyn-street, S.W., 4¾ p.m. Mr. Arthur L. Bowley, "Changes in Average Wages in the United Kingdom, between 1860 and 1891."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Walter E. Collinge and Lt.Col. H. H. Godwin-Austen, "The Structure and Affinities of some New Species of Molluscs from Borneo." 2. Mr. F. E. Beddard, "Preliminary Account of New Species of Earthworms belonging to the Hamburg Museum." 3. Rev. W. J. Holland, "A Synonymic Catalogue of the *Hesperiidæ* of Africa and the adjacent Islands, with Descriptions of some apparently new Species."

S ary Institute, 74A, Margaret-street, W., 8 p.m. rofessor A. Wynter Blyth, "Diseases of Animals in Relation to Meat Supply."

Wednesday, March 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. H. F. Lester, "The Progress of the Abattoir System in England."

Meteorological, 25, Great George-street, S.W. 7½ p.m. Mr. W. N. Shaw, "The Motion of Clouds Considered with Reference to their Mode of Formation."

Geological, Burlington-house, W., 8 p.m. 1. Mr. S. S. Buckman, "The Bajocian of the Mid - Cotteswolds." 2. Mr. C. S. Du Riche Preller, "Fluvio-glacial and Inter-glacial Deposits in Switzerland."

Microscopical, 20, Hanover-square, W., 8 p.m. Mr. W. H. Brown, "Patents connected with the Microscope from 1666 to 1800 A.D."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Botanic Gardens, Regent's - park, N.W. First Spring Exhibition.

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. J. R. Gotz, "Modern Lenses."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Thursday, March 21...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. F. W. Keeble, "Observations on the Loranthacea of Ceylon."

Chemical, Burlington-house, W., 8 p.m. "Studies in Isomeric Change" (Part III.). 1. Dr. G. T. Moody, "The Ethylbenzenesulphuric Acids." 2. Miss Sedgwick and Dr. Collie, "Some Oxypyridine Derivatives." 3. Mr. A. G. Perkin, "The Colouring Principle of Toddalia Aculeata and Evodia Meliaefolia."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. S. R. Gardiner, "Three Periods of 17th Century History." (Lecture III.—The Restoration.)

Historical, 20, Hanover-square, W., 8½ p.m.

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne. Mr. E. F. Moroney, "Screw Propeller Shafting."

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. W. Hodgson, "Evolution of an Illustrated Paper."

Imperial Institute, South Kensington, S.W., 4½ p.m. Professor J. J. Hummel, "Indigo and its Modern Substitutes."

Friday, March 22...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Sir Wemyss Reid, "Emily Brontë."

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. (Students' Meeting.) Mr. G. B. Williams, "Pipe-Syphons under the Ouse, at York."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. Louis Parkes, "Water Supply: Drinking Water, Pollution of Water."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Royal College of Science, South Kensington, S.W., 5 p.m. 1. Prof. A. W. Rücker and Mr. Edser, "The Objective Reality of Combination Tones." 2. Dr. C. V. Burton, "Some Acoustical Experiments." 3. Mr. Herroun, "The Use of an Iodine Voltameter."

Saturday, March 23...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Waves and Vibrations." (Lecture IV.)

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FRIDAY, MARCH 22, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

AFTERNOON LECTURE.

On Thursday afternoon, 14th inst., Professor Hubert Herkomer, R.A., delivered a lecture on "Art Tuition."

No report of the lecture will be printed in the *Journal.*

CANTOR LECTURES.

On Monday evening, 18th inst., Dr. D. Morris, C.M.G., delivered the first lecture of his course on "Commercial Fibres."

The lectures will be printed in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday evening, March 19; J. Hungerford Pollen in the chair. The paper read was "Practical Carpet Designing," by Alexander Millar.

This paper will be published in the next number of the *Journal.*

TEN-VOLUME INDEX TO "JOURNAL."

The new Index to the *Journal of the Society of Arts*, for volumes xxxi. to xl. (1882-1892), is now ready, and can be obtained by members on application to the Secretary, John-street, Adelphi.

Some copies of the three previous ten-volume Indexes are still in stock and can also be obtained by members on application.

The price to non-members of each index is Half-a-crown.

Proceedings of the Society.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 20, 1895; Sir Benjamin W. Richardson, M.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Bones, Arthur Anderson, Broadgate, Coventry.
Elliot, George Francis Scott, M.A., B.Sc., Newton, Dumfries, N.B.
Malcolm, Alfred, 499, Ashton New-road, Clayton, Manchester.
Master, Charles Gilbert, C.S.I., Earlsridge, Woodlands-road, Redhill.
Pennell, Joseph, 14, Buckingham-street, Strand, W.C.
Sandercock, Thomas J. Buckler, Sidcup College, Kent.

The following candidates were ballotted for and duly elected members of the Society.

Aldis, Thomas Steadman, 37, Pembury-road, Clapton, N.E.
Burn, Robert G. L., 23 and 24, Charing-cross, S.W.
Chapman, John, The Lawn, Torquay.
Drew, Alexander, jun., Holme-lodge, Burnley, Lancashire.
Muddiman, Thomas, 35, Amhurst-park, N.

The paper read was—

THE PROGRESS OF THE ABATTOIR SYSTEM IN ENGLAND.

By H. F. Lester,

Hon. Secretary to the London Model Abattoir Society.

The time has gone by, if it ever existed, when an apology was needed for calling attention to the enormously important subject of our meat supply. From a hygienic point of view what can be more necessary than the prevention of the dangers arising from the sale of diseased meat, and of those other sanitary perils involved in the continuance of private slaughtering places in localities crowded with human life? From the standpoint of public policy it seems to be equally essential that animals on their way to conversion into joints for our tables should be subjected to no inhumane treatment, because permitted cruelty is not only bad for the dumb victims, but also tends to brutalise the operators and to blunt and demoralise the public conscience. We

gain an added idea of the vastness of this question when we are told that the amount of animal food consumed by the community in the course of one year was estimated eight years ago at 1,570,000 tons, or an average of 98lbs. per man, woman, and child of the population. For good or evil it must be admitted that we are at present partly a carnivorous race, what ever we may hope to become in the future.

What are abattoirs, and what is the abattoir system? The word "abattoir" has come into use for reasons of convenience, because it is shorter and at the same time more euphonious than the words "public slaughter-house," of which it is an equivalent. As we have borrowed the words "mutton" and "beef" from the French, to veil the fact that we are eating sheep and bullock, we may, in the same way, borrow the substantive which denotes the place where mutton and beef are manufactured. An abattoir, then, is a public slaughter-house, and the abattoir system is the system which provides for the killing of animals in public as opposed to private places. A public slaughter-house, however, may mean two things. It may mean that the building is one open for the inspection of the public, or that the public are the owners; and when we speak of publicity in this matter, we really include both interpretations. An abattoir in the true sense of the term ought to be a building for the purpose of the killing of animals for food, which is owned and regulated by a municipal body as representing the people, and also one to which members of the public can have access under reasonable restrictions. It would be most injurious to allow youths or children to enter an abattoir, and see all the details of the work that goes on there, merely from motives of curiosity; that course would tend to produce exactly the same evils which are found to result in many places from private slaughter-houses, where children hang about the doors, and peer through cracks in the fence, with the usual juvenile delight in sensational developments, but to their own gradual demoralisation. The public eye, however, is a great safeguard against all manner of evils, and an abattoir, therefore, besides being the property of the public, ought to be capable of having surprise visits paid to it by members of the public, as amateur inspectors of nuisances.

English municipalities are now waking up to the great advantages which attend the establishment of abattoirs; but it has taken them a very long time to make the discovery. From earliest times the business of slaughtering of animals for food has been in private hands, and, down to the present century, the efforts to regulate it were few and far between. It is true that, in 1388, in the reign of King Richard II., an Act of Parliament forbade casting of offal, and other refuse of slaughtered animals, into rivers, ditches, and waters; but this regulation was afterwards relaxed, the compromise which was come to in London being that the offal, before being thrown into the Thames, must be cut into small pieces. Then, in 1489, an Act prohibited the "slaying of any manner of beast within the walls" of London, or any other walled town in the kingdom, except Berwick and Carlisle. Why the proud privilege of poisoning their inhabitants should have been reserved to the two latter places it is a little difficult to understand; but so it was.

What private slaughter-houses resembled, under this *laisser faire* system, early in the present century, can be gleaned from the report of the Commission on the sanitary condition of our towns which was appointed in 1844, and of which Lord Playfair was a distinguished member. In Manchester there were 77 slaughter-houses, all without regulation or inspection of any kind. Sometimes they were beneath dwelling-houses, and, in all cases, dwellings were in close proximity. It was noticed that the smells resulting were most offensive, although some people were found who declared that these odours were "very healthy;" and the residents in courts close to the slaughter-houses were sickly and pale, and were afflicted with ailments which were absent from neighbouring courts. In scarcely any town, the report declared, were there any regulations or any supervision for the removal of the refuse, proper ventilation, or cleansing. "The private slaughter-houses of that period were found to be, almost without exception, noisome centres, deteriorating the sanitary condition generally of poor and dense neighbourhoods, and constituting a general nuisance."

For the last half-century the Legislature has made repeated efforts, by means of various Public Health Acts, to deal with this matter. It has given magistrates and municipal bodies power as to new slaughter-houses, by placing in their hands the right to grant or withhold a license; and even over old ones it has given a measure of control, by the power to close them on breach of certain sanitary regulations. Gradually the legislative net has been closing round the butcher, so that now

London has almost complete power to deal with any particular insanitary slaughter-house, and any provincial town can gain a like power by adopting the Public Health Act of 1890. But Parliament has never yet pronounced frankly and boldly against the private slaughter-house system and in favour of abattoirs; it has given municipalities power to erect abattoirs if they choose, but not to close private slaughter-houses concurrently, so that some towns which have built excellently-equipped abattoirs find that they are of no use, as the butchers prefer to go on killing where they have been accustomed.

In London the County Council has done admirable work in declining to renew the licenses of the most offensive private slaughter-houses. Yet those which remain, in too many instances, sin against all known sanitary and humane principles. Here, for example, is a description of a London private slaughter-house as it exists at this moment:—

"A long, low-roofed, narrow apartment. Very dirty, and ventilation insufficient. The floor made of old defective cement. The lair (or place where the animals wait) is just one end of the apartment barricaded off with a low partition of zinc-covered wood."

Here is another specimen:—

"A very small pig-killing place. The lair is a little corner of the room, big enough for one pig. The room itself, where killing and hanging both take place, is about 12 feet by 8 feet. The approach is through the shop by a winding passage. The window of the shop opens into the slaughter-house."

It need hardly be said that in such places the provisions for catching the blood and preventing it and other impurities flowing into the drains are of the most primitive and inefficient character.

You may ask, "Are not these places inspected? And would not an inspector prevent cruelty and other evils when he saw them?" In answer to this it is sufficient to say that to properly inspect 600 slaughter-houses 600 inspectorswould be needed. If you have an abattoir, where all animals that are killed in a town must be taken, one superintendent can inspect everything; but to prevent cruelty in all the private shambles of a large town an army of inspectors is essential. At present a private slaughter-house is an Englishman's castle and the public cannot get into it, and inspectors visit it but rarely. It must be remembered that these inspectors are not solely appointed to inspect slaughter-houses, but have also cast on them scores of duties connected with various Acts of Parliament, such as the supervision of workmen's dwellings, and the multifarious matters dealt with in the Factory Acts and the Public Health Acts. Indeed, a medical officer of health in London informs me that the inspectors have so much to do, that they are kept running about all day, that he himself would be surprised if they visited any particular slaughter-house oftener than once in three months, and that the inspection, as far as preventing the sale of unsound meat, is a mere farce. There are between five and six hundred private slaughter-houses in London, and the County Council's inspectors numbered five in 1893; but this does not include any inspectors appointed by local sanitary authorities in their respective districts.

It will thus be seen that although Public Health Acts have mitigated the evils of private slaughter-houses, they have by no means abolished them. It is Paris that has set the example of public slaughter-houses to the rest of Europe. In 1818, the five large Paris abattoirs were opened; but it was not till considerably later that any town in the United Kingdom followed that excellent example. The Edinburgh abattoir, for example, was built in 1851, the Manchester abattoir in 1872.

I come, now, to the case of the English and Welsh towns that have established abattoirs, and I wish to draw special attention to the results which have followed from their introduction. In isolated instances, these places have been erected by companies; thus, at Liverpool, there is a very old abattoir built in this way; but it cannot be said that that instance is at all favourable to the practice of great public undertakings being taken out of the hands of the municipal bodies which ought to control them, and transferred to the members of a mere profit-making company. The Liverpool abattoir is, in some respects, inferior to an ordinary private slaughter-house. It is situated in the heart of a crowded locality, and the evidence of the medical officers of the district, which was quoted by Colonel Sandys in Parliament, only a short time ago, shows that the death-rate in the neighbourhood of this building is 30 per cent. higher than in the rest of Liverpool. The nuisance, in fact, became so great that the Liverpool Corporation have definitely decided to remove the abattoir elsewhere.

The real abattoir system is that which depends, not on companies, but on municipalities. The society, of which I am the hon. secretary—the London Model Abattoir Society—was founded some ten years ago in order to

improve the methods of slaughter-houses generally, and with a special belief on the part of most of its supporters that private slaughter-houses would have to be done away with. In 1887, and again in 1892, we communicated with all towns in England and Wales which had abattoirs, with a view to finding out what had been the effect of their establishment. In the first of those years we found that only 27 towns had gone in for this improvement, but now there are upwards of 50; and the fact that, in the short time between 1887 and 1892, more than 20 municipalities had adopted the reform, certainly indicates the rapid advance of the movement. I should like to briefly lay before you a few quotations from the evidence supplied to us from the towns which have tried the abattoir system. The opinions are those of town clerks, medical officers, borough engineers, and market superintendents.

Carlisle.—"All slaughtering is done in the public slaughter-houses under the supervision of the servants of the Corporation. The slaughter-houses in this city are, I am informed, of the most improved and complete kind, so much so that they have been visited by deputations from all parts of the kingdom. The officials take active steps to prevent cruelty. The change has certainly done good in preventing the sale of diseased meat. In the event of the inspector—who was formerly a butcher and dealer of experience in the town—suspecting any animal, the medical officer is called in to inspect the same, and on his certificate it is destroyed. The slaughter-houses have entailed a small loss, yearly diminishing. However, the Corporation consider that the loss is more than compensated in the advantages which the public receive in being assured that none but good meat is sold in the city, and for other sanitary reasons. The receipts considerably exceed the expenditure, with the exception of the interest on the debt, and we consider the result very gratifying. The only cause for a loss is the small charges made for slaughtering.

Clevedon.—The establishment of a public slaughter-house has done good, in preventing the sale of diseased meat. One or two cases of slaughtering diseased animals that have been discovered would never have been heard of, if they had happened in private slaughter-houses. In addition to butchers, some tradesmen and cottagers, who keep pigs, send their animals to be slaughtered, where they have every convenience for scalding, &c., provided at a small charge. The receipts, on an average, just about balance expenses; and as the slaughter-houses were provided on account of the public health, and not with the idea of profit, I suppose we must look upon them as a practical success.

Birkenhead.—We are free from the many and intolerable nuisances which exist in many towns through private slaughter-houses. Our inspection of meat is far better than in towns where the inspector has to run backwards and forwards several times a day into private slaughter-houses scattered all over a town.

Exeter.—The establishment of the public slaughter-houses, where the killing is open, undoubtedly prevents unnecessary cruelty, and its beneficial operation in preventing diseased meat being skilfully dressed, and so offered to the public, is considerable, and has been more and more recognised by the public, many householders declining to deal with any butchers but those who slaughter at the abattoir.

Halifax.—There is no doubt that in a public slaughter-house less cruelty goes on than in a private one. The prevention of the sale of diseased meat is easier. In a financial point of view, the slaughter-houses have always paid their way, but profit has not been an object aimed at so much as public inspection.

Swansea.—There is certainly less cruelty resulting from the establishing of abattoirs. Their existence tends to prevent the sale of diseased meat, and therefore is of great benefit to the community. The abattoirs have been a pecuniary success. A sum of £10,500 was spent in erecting them, and we receive a rental of £1,000 per annum.

Manchester.—The abattoirs were opened at Christmas, 1872, the area is about 17,188 square yards, and the ground-rent £1,000 per year. The cost of the buildings has been between £50,000 and £51,000; our profits are about 5 per cent. Success is mainly due to having a carcase market attached."

There is one point which is certainly worth notice. In a private slaughter-house, as has been said, the collection of blood is carried out in a most unsystematic way, while much of it is often allowed to flow into the drains. In a large abattoir this valuable product is carefully stored and sold to albumen factories, in which it is most useful in the printing of calicoes. Then there is the great convenience that in an abattoir there are special triperies and pig-scalding places, as well as refrigerating chambers for the storage of meat.

It is impossible, in the limits of a short paper, to deal with all the objections which are persistently advanced by persons interested in the continuance of the present system; but one objection which we often hear of perhaps requires a brief notice. This is what I may call the great offal argument, which is calculated to have considerable effect on people of a philanthropic disposition, who are also willing to believe everything that butchers tell them. The argument is that when you have slaughter-houses scattered all about a district, the poor can easily obtain a supply of offal as food; when killing is done in an abattoir they are unable to obtain this supply. Now I have made inquiries in some of the cities where abattoirs are set up, and I find that no such result follows. In London, within the last twenty years, private slaughter-houses have decreased in number by about four hundred, or nearly half; so that offal ought even now to be double as hard to get as it used to be, yet we hear no such complaint. With an abattoir these inferior parts of the bullock can be cleaned in a way impossible in private places, and are taken away by the butchers to their shops exactly like any other part of the meat. The opinion of a large London butcher on this point may be of some interest. He writes:—

"Suppose the retail butcher buys the cattle alive he has to pay so much a head for killing. Now if butchers had a proper place for killing, one and all alike, it would put them in a position of buying of the first seller, and give a great benefit to the public, especially to the poor, who would be able to buy the offal, *which they never see now.*"

So that here we have a butcher actually complaining that it is the private slaughter-house system, and not the abattoir system, which deprives the poor of the cheap parts of meat. The most amusing point about this argument is the fact that the offal is that part of the animal which the butcher pays nothing at all for—it is a perquisite of his by old custom, and it might be suggested to him that if he wishes to benefit the poor he should hand on the offal free of charge to them, as he himself receives it free of charge from the grazier.

Now I should like to turn to another branch of this subject, and not the least important branch—the prevention of inhumanity. One great object with which the Abattoir Society was started was to introduce more painless methods of slaughter; and it is hopeless to expect that those methods will be adopted by private butchers in their own little slaughtering dens. That is another strong reason for advocating abattoirs, because it is through them, and through them alone, that we can reasonably expect the humanisation of the slaughter-house. The private butcher dislikes change, he has no room for fitting up apparatus, and he dreads expense. In an abattoir the expense of painless appliances, owing to the scale on which the work is conducted, is reduced to a minimum, while there is of course ample space for a lethal chamber, or instantaneous guillotining, or the use of shooting-masks, or whatever other apparatus may be decided upon. One word of warning, however, is needed. There is no certainty that merely setting up an abattoir will lead to the disappearance of cruelty. It no doubt tends in that direction, because of the greater skill of the practised operators who are there employed; but whether cruelty shall exist or not is a matter of superintendence. A humane superintendent can put an end to cruelty, because he is constantly present; whereas in a private slaughter-house the only approach to supervision is a hurried visit from an overworked inspector about once in two or three months, and very likely on a day when no killing is being done.

Sir Benjamin Richardson has already made public the merciful method of rendering the smaller animal unconscious before death which was practised in the model slaughter-house built for the Abattoir Society at Croydon. It is an admirable plan, and no detriment was suffered by the meat. For large animals it may be doubtful what is the best mode of execution. The Baxter or Burneau bolt-masks render a chance of a series of bad shots being taken, as may happen with the pole-axe, almost out of the question; while there are many who prefer the shooting-mask, which is in use in many parts of the continent. I have found that quite a number of English butchers even now prefer shooting bullocks to poleaxing them. The Coniston butcher who kills for Mr. Ruskin habitually uses a Martini-Henry rook rifle, with a very small cartridge, and shoots his beasts in the forehead. Not one animal in a hundred, he says, has the least fright or pain, and the total cost of each execution is one penny. In another instance, the gun used is a 410 bore shot gun, with a small cartridge containing about $\frac{1}{4}$ oz. of shot; but for meat purposes, in order to avoid the trouble of extracting shot, it would be better to use a bullet. Any common gun, even an old smoothbore muzzle-loader, with a moderate charge of powder and small bullet or wooden plug, would be quite effectual. The mask for cattle

that is used in German abattoirs is one that can be fitted on to the head, covering the eyes; in its centre is a steel punch with sharp edges, which can be driven in by a blow with a wooden mallet weighing about six pounds. All the fright preceding the death-blow is in this way avoided, and it is almost impossible for the animal not to be stunned at the very first blow. The shooting-mask also fits on to the heads of the animals, only in place of the steel punch there is a small pistol, which is fixed so as to fire a bullet into the animal's skull. Sheep, lambs, hogs, and calves are also stunned by a bolt and mallet apparatus; and an appliance has been invented, and is in use, for practising the slaughtermen in the use of the mallet. In Switzerland, Saxony, and, I believe, some other countries, it is obligatory by law to stun before killing.

It may very naturally be asked—if there are such obvious advantages to be derived from this abattoir system, why has it not been adopted all over the kingdom? One most powerful reason is to be found in the legal obstacles which exist. Suppose a town wishes to get rid of its private slaughter-houses, and set up an abattoir, the steps which it must take are as follows. It may go to the expense of getting a local Act of Parliament giving such powers, but unless it has come to an agreement with the butchers beforehand, an agreement which, ordinarily, means compensation, the Act may be opposed at every stage, and on the plea of injustice to vested interests, is very likely to be thrown out. If the town does not proceed by means of a local Act, it can set up an abattoir on the chance of the butchers taking to it, or in the hope that the licensing authority may gradually force butchers to use it by granting no new licenses for private slaughter-houses, both of which expectations are often proved in the event to have been quite fallacious. Or the town may wish to act rather more prudently, and if so, it will probably try to put in force the last Public Health Act, of 1890. In order to do this, there must first be a month's notice given of a resolution to adopt the Act, then the meeting takes place, and the Act is formally adopted, though it may be taken for granted that the butchers will use their influence to get the resolution defeated. But suppose the Act of 1890 is adopted, then the town obtains the power to limit the time for which all new slaughter-house licenses are granted to any time it likes to fix, not being less than a year. It gains no power whatever over old slaughter-houses, and the best legal opinion is that there *is* no power to shut up these places, except for a violation of bye-laws. All that is gained by adopting the Act of 1890 is a power to revoke any licenses subsequently granted; and even this power has two important qualifications. In the first place, each case must be considered on its individual merits, and no wholesale closing of private slaughter-houses would be allowed; and in the second place there is an appeal from the licensing authority to the magistrates at the quarter sessions, who might possibly see fit to take the side of the butchers. A review of these obstacles is enough to account for the continuance of the private slaughter-house system in this country, in spite of all efforts to dislodge it. It is a legally protected nuisance. So that when the Public Health Act of 1875 gave power to municipalities to erect slaughter-houses, it really mocked them by giving them at the same time no power to abolish private slaughtering places. What is wanted is a short and simple statute frankly giving municipalities the right to get rid of all private slaughtering places under such conditions as shall do no injustice to the private interests concerned.

So much for towns, but how about rural districts? Here there is no need even of a license; the butcher kills in a shed, the farmer kills in his yard, without any interference, either sanitary or humane. But it is perfectly obvious that if we are really to be protected from the danger of diseased meat, there is as much need for rigid inspection of country-killed as of town-killed animals. How is this to be obtained? It may seem a little cruel in this time of agricultural depression to suggest that abattoirs ought to be planted in country districts, but, fortunately, it is easy to show that the farmer would gain in pocket as much as the meat-eater would gain in the quality of his meat from the adoption of this system. The loss which the farmer incurs by sending his beasts to a railway, and thence having them conveyed alive to a city, is fourfold. The mere loss of weight through the treatment the animal goes through in transit, is estimated at an average value of 30s. per beast; there is the loss involved in the commission charged by the city salesman; there is the loss of the value of the offal, which has to be "thrown in" when sold to a butcher, and this value is put at about £3 per animal; then the price of carriage for the carcase is much less than for the live animal, and

besides, the meat arrives in better condition, and can command a better price. If we could persuade the farmers that there could be a gain on each bullock of somewhere about £4 or £5 by this plan, they would probably look with greater favour on the idea of rural abattoirs close to the railways, and at convenient places in all country districts; and by establishing these shire abattoirs, we should complete the cordon of sanitary safety round the meat-eaters in towns.

The position of London in regard to this matter is very extraordinary. The London County Council has been presented by the Act of 1891 with power to close any private slaughter-house by the simple device of declining to renew its license; and though this power cannot be used wholesale, yet the worst specimens of private slaughter-houses are gradually disappearing. It seems, however, that London has no power to erect abattoirs, and that if the County Council desired to erect them, it would have to obtain powers from Parliament. If this is the case, and we have taken legal opinion on the subject, it is certainly an extraordinary disability to inflict on the capital city, when any little provincial town can erect abattoirs.

Practically, however, this disability would not be of much avail to stop the abattoir system being adopted in London if our rulers were once to make up their minds as to the necessity of the reform. What I should venture to suggest is that one or two large abattoirs should be built outside London, at places convenient for the railways, as a beginning. Concurrently the private slaughter-houses in the districts which these abattoirs would serve should be closed. But prior to erecting the abattoirs a census of private slaughter-houses in a certain radius should be obtained, with the number of cattle slaughtered weekly and the number of butchers' shops. In this way we should gain a fairly accurate notion of how many butchers would be likely to patronise the abattoirs. This idea of a census, I may add, is the suggestion of Mr. Thomas Gregory, market superintendent at Birkenhead.

Our chief need, I venture to think, is legislation, to close the era of the antiquated private slaughter-house, and to enable the abattoir system to start with a fair chance of success. But, even without legislation, municipalities could hardly be better employed than in ministering to the public health, by attempting to put in force the powers which they already possess. They should be encouraged, by the very substantial success which has already followed the establishment of abattoirs, and by the fact that in many places the butchers themselves have readily agreed to use these places, because of the great conveniences they possess, and the low charges which are made in them. We must steadily oppose any recognition of a right to compensation on the part of a butcher for loss of a slaughter-house license. There is much less moral claim on his part to compensation than on the part of a publican, because the loss of a license to the latter means the loss of a livelihood; whereas, with the butcher it only means that he must procure the material of his business in a slightly new direction. And within a year or two after he has been using an abattoir he will himself wonder how he could have endured the cramped conditions, the dirt, the inhumanity, and the general unsavouriness of a private slaughter-house.

DISCUSSION.

The CHAIRMAN said whatever views might be held on this subject, they were all indebted to Mr Lester for the skill with which he had condensed into a small space so much information. It was a matter which was exciting a good deal of attention on all sides, and he felt sure that it would not be allowed to rest until a settlement had been arrived at. If he had his own way entirely, he did not know that he should go in for reforming slaughter-houses at all, but for something more radical. Some 14 or 15 years ago, in that room, he proposed a plan of preparing food which had no relation to killing at all, seeing that science had made such advances in its knowledge of what was required in the way of food, how it was digested, and the elements required for promoting healthy life, that the chemist should be able to prepare from the vegetable world foods which would be identical in all important features, including flavour, with animal food. He held then, as he did still, that the bare vegetarian system would never answer; that vegetables, to be digested and assimilated by the animal body, entailed an amount of work which was physically very costly. He pointed out, for example, that in a purely carnivorous animal, such as a lion, there were only two or three lengths of intestines for doing all the work, because it got its food from animals which fed on plants, whilst in a herbivorous animals there were something like 30, or even 36 times the length of intestine and digestive canal to do the work, which meant an enormous amount of labour on the part of the animal, so that it often did nothing but graze, digest its food, sleep, and make flesh. Therefore man, if he were to become a pure vegetarian, would be furnished

with an enormous digestive apparatus, and would lose a great deal of power which might be applied to the work of life in a much better manner. He, therefore, suggested that chemists should take up the task of making vegetable food into that which would resemble animal food, and adapt it to all the purposes required. He should not work *ad captandum*, but for a variety of foods exactly adapted to all seasons and conditions, so that each person could select just that which would suit him, so that physiological advantages might result from the process. This idea had attracted a good deal of attention since he had first proposed it; he had done something towards realising it, and he hoped one day to bring the matter again before the Society. Recently, in France, a distinguished chemist, Berthelot, had enunciated similar views, and some scientific men were going still further, and proposing what he believed was very unlikely to be accomplished, viz., the making of food synthetically from the inorganic world. It was quite true that organic substances had been made from inorganic, and it might be that in centuries to come, chemistry would go as far as to make any organic substances which were wanted in any required quantity from inorganic matter, but that was not necessary at present. What was wanted was what might be called chemical laboratories instead of herbivorous laboratories. At present the herbivorous animal is a laboratory for man, he takes grass and turns it into flesh. They did not want to turn inorganic structures into animal structures, but they did want to turn vegetable compounds, in which half the work was done, into flesh-like foods. Probably they would not beautify creation if they attempted to go further, and it was not necessary. They wanted merely to take what nature presented to the herbivorous animal, and studying carefully and properly the digestive process of that animal, produce the meats which were required. He ventured to predict that this would be done long before the end of the next century, and that all human food would be brought to their doors in that way. He had no doubt that a fluid identical in every sense with milk would be produced in that way, possessing exactly the same chemical qualities as milk, and being in every way as nutritious, and very much cheaper. And the same with regard to flesh of various flavours and characters. He mentioned this again, after the lapse of so long a time, because he felt certain that in due time it would come about. He would now come to the question of the paper. They could not expect to see these results he had named immediately, and in the meantime they must depend largely on animals for food. The taste of the people would long remain connected with the idea of food derived from animals; science would be slow in getting the various tastes for the food which it produced, and the commerce of the world would have to be changed, which again would be a slow process. They had, therefore, still to consider the preparation of animal food, as Mr. Lester had done, and he went with him entirely in what he had said, not from any desire to do injury to the butcher, but for the sake of the people and of the animals themselves. There was no denying that in private slaughtering there had been until quite recently a great deal of unnecessary cruelty, and there was still. The last time he witnessed, in company with Mr. Colam, Mr. Lester, and others, the slaughtering even at Deptford, they saw a great deal that required amendment, and that sort of thing would go on until all places where animals were slaughtered were brought under the public gaze. It sometimes happened that the men employed were too young, sometimes were too weakly, and often too tired for their duty. Sometimes the animals were not properly attended to before they were killed, they were not killed as expeditiously as they might be, and they were not preserved and utilised as fully as they should be. A better system would also be an advantage to the men employed. At present butchers were not healthy, they died at a considerable rate; the mode in which they worked and the exposure and temptations to which they were subjected were all against them. When the model abattoir at Croydon was built great pains were taken to provide all necessary facilities for the men washing themselves, and the place was like a drawing-room in comparison with many ordinary slaughter-houses. He could not praise very much all that was done in some public abattoirs. For instance, in Paris, the men were under less disadvantages than most of those in London, but great improvements were required there. Again, there could be no doubt that the public health would benefit by the introduction of a new system, under which there would be more rigid inspection. The Jews' mode of inspection was very rigorous, perhaps unnecessarily so, but they sold many tons of meat at a loss of 10 or 12 per cent., which they considered diseased, and passed it on to the Gentiles, a fact that, at any rate, suggested that more inspection was required. It was astonishing to see the quantity of diseased meat passed into the market in some places. In Paris one morning he was shown a quantity which had been condemned, and he was quite astonished at the extent of it. There every animal was inspected before slaughtering, and if found to be diseased was not allowed to be killed for human food. Another undoubted advantage would be economy, for which Mr. Lester had given some figures. No one could watch cattle driven to market in towns without seeing that there must be an enormous loss, which would be saved to a great extent if the cattle had not to be driven so far. This showed the importance of having nearly all the slaughter-houses in the country. He should not recommend many being built in London, as he told a committee of the London County Council the other day, a view most of the members seemed to agree with. A few abattoirs in London itself would be sufficient. What the Society desired was that there should be two or three in every

county near the railways with good preserving rooms, so that the cattle might be driven only a moderate distance, killed in a painless and rapid manner, retained until wanted, and then sent on to the markets. He was glad to know that many farmers were considering the question, and were beginning to discover the advantages they would derive. With regard to modes of killing, he had never seen the pistol mask in operation, but he had seen one like it, and it was not very successful. He had also seen a mask where the butcher struck a blow on a punch which went into the skull, as in Baxter's and Burneau's masks, and they worked very well indeed. On the whole, for large cattle, he did not think there was any better method than a blow, and a man who could use the pole-axe well did best of all, but it required a deal of skill. Some years ago, when he was making some researches on the blood, he had a laboratory in a large slaughter-house, and oftentimes saw ten or fifteen bullocks killed in a morning, and he was astonished at the rapidity with which one particular man did his work. He never knew him to miss a stroke, and the animal always fell at the first stroke, until he (the man) got tired; then another man would succeed, and sometimes do very bad work. On the whole, the pole-axe was the best and most rapid method of killing a large animal. The lethal chamber was a very good method for small animals. At Croydon they could produce complete insensibility in a sheep in nineteen seconds. The slaughterer carried the lethal vapour in an elastic bag on his back, he would go into the lair, catch a sheep, and putting a nozzle over its nose, make it insensible by the time it got to the place where it was killed. It was then killed in the ordinary way, bled freely, and the flesh was altogether untainted. Whether the method would apply to large animals he did not know, though it could be adopted by having a chamber large enough to drive them into. He was quite sure that when butchers recognised the advantages of public abattoirs, they would wonder why they had stood out against them, as some did; and he trusted that this paper and discussion would lead to the subject being considered in a friendly spirit on all sides, so that the great advances indicated might be speedily accomplished.

Mr. F. W. PRICE asked how the great slaughterings in Chicago, in Australia, and the River Plate were carried on.

Mr. LESTER said he could say something about Chicago, from what he heard, as he had never seen it. In some of the slaughtering-yards, the bullocks were ranged along a great shed, and a man went along a plank above their heads and dropped a very heavy spear into the back of their necks, and they dropped at once. But it was a question whether this was really a humane plan, as some scientific people said it merely paralysed the animal without actually producing insensibility. He believed a similar system was adopted in Russia.

Sir H. TRUEMAN WOOD said he spent nearly a year in Chicago, two years ago, and although he did not visit the stock yards, he heard a good deal about them. In some, the plan mentioned by Mr. Lester was used, in others, the man who walked along the plank shot the cattle with a rifle, and in others the pole-axe was used.

The CHAIRMAN then moved a vote of thanks to Mr. Lester which was carried unanimously, and the meeting adjourned.

Correspondence.

MEAT SUPPLY OF THE UNITED KINGDOM.

Mr. NELSON writes that "the complete carbonic anhydride machine with circulating pipes," used at Messrs. Nelson's Freezing Works at Tamoana, is the machine of Messrs. J. and E. Hall (23, St. Swithin's-lane), and that the name was inadvertently omitted in the printed paper (see *ante* p. 423, col. 2, lines 46—48).

Obituary.

JOHN BELL.—Mr. John Bell, the eminent sculptor, who died at his house at Kensington on Thursday, 14th inst., was a member of the Society of Arts from 1847 to 1878, and was a member of the Council in 1849-52, 1859-63, and 1866-69. In 1859 he read a paper before the Society entitled "Some Remarks on the Application of Definite Proportions and the Conic Sections to Architecture, illustrated chiefly by the Obelisk, with some history of that feature of Art," for which he received the Society's silver medal. In the following year he read a paper on "The Art-Treatment of Granitic Surfaces," and in 1861 one on "Colour on Statues, Colour round Statues, and Painting and Sculpture arranged together." Mr. Bell was born in Norfolk in 1811, and early in life displayed his taste for sculpture. He exhibited at the Royal Academy in 1832, and in 1841 he produced his figure of "Dorothea." Among the statues of statesmen in the Houses of Parliament he executed those of Lord Falkland and Sir Robert Walpole. Among his numerous works may be mentioned specially the Guards' Memorial in Waterloo-place, and the colossal marble group of the United States directing the progress of America, which forms a part of the Prince Consort memorial in Kensington-gardens.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

MARCH 27.—"Modern Photogravure Methods." By HORACE WILMER. GEORGE DAVISON will preside.

APRIL 3.—"Sand Blast Processes." By JOHN J. HOLTZAPFFEL.

Papers the dates of which are not fixed:—

"The Use of Aluminium in the Separation of Metals from their Oxides." By PROFESSOR WILLIAM CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. CHARLETON, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. CROMPTON, M.I.E.E.

"Electric Lighting of Ecclesiastical Buildings." By MAJOR-GENERAL CHARLES E. WEBBER, C.B.

"Improvements in Milling Machinery." By J. HARRISON CARTER.

"Deviations of the Compass." By PROFESSOR A. W. REINOLD, F.R.S.

"Means for Mitigating the Fading of Pigments." By CAPTAIN W. DE W. ABNEY., C.B., F.R.S.

INDIAN SECTION.

Thursday Afternoons, at Half-past Four o'clock:—

MARCH 28.—"Chitral and the States of the Hindu Kush." By CAPT. F. E. YOUNGHUSBAND, C.I.E. THE HON. GEORGE CURZON, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

APRIL 2.—"My Recent Voyage in Siberia." By CAPTAIN WIGGINS.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

DR. D. MORRIS, C.M.G., "Commercial Fibres." Three Lectures.

MARCH 25. — LECTURE II. — Fibro - vascular bundles in monocotyledonous plants—Bast fibres and vessels—Disposition of bundles in stems and leaves—Component fibres—Ultimate fibres—Manila (plaintain) hemp—Sisal hemp—Bahamas pita—Mauritius hemp—Bombay aloe fibre—Manila aloe fibre—Mexican brush fibre—New Zealand hemp—Yucca fibre from stem and leaves—Bowstring hemps—Somali-hemp—Pineapple fibre—Caraguatá hemp from Argentine—Pinguin fibre—Karatas or hammock fibre—Oil-palm and other palm-leaf fibres.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. D. Morris, "Commercial Fibres." (Lecture II.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Mr. W. B. Blaikie, "The Cosmosphere." 2. Dr. Dawson Turner, "A New Method of exhibiting the Phenomena of the Spectrum Top, with experiments."

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. W. M. Conway, "Climbing and Exploration in the Karakoram Himalayas."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. H. Burrows, "Sound in its Relation to Buildings."

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Leon Warnerke, "Description and Demonstration of Mr. Warnerke's Half-Tone Relief Process.

TUESDAY, MARCH 26...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "Internal Framework of Plants and Animals." (Lecture XI.)

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. E. C. Seaton, "Infectious Diseases and Methods of Disinfection."

Civil Engineers, 25, Great George street, Westminster, S.W., 8 p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Technical Meeting. "The Evolution of Photographic Objectives, with an Exhibition."

Colonial Institute, Northumberland-avenue, W.C., 4½ p.m. Mr. James Borwick, "The Writing of a Colonial History."

WEDNESDAY, MARCH 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Horace Wilmer, "Modern Photogravure Methods."

United Service Institution, Whitehall, S.W., 3 p.m. Major A. J. Hughes, "Field Artillery Fire and Okehampton Experiences."

Royal Society of Literature, 20, Hanover-square, W., 8 p.m.

Chemical, Burlington-house, W., 3 p.m. Anniversary Meeting.

THURSDAY, MARCH 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Captain F. E. Younghusband, "Chitral and the States of the Hindu Kush."

Royal, Burlington-house, W., 4½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. P. H. Newman, "Colour in its relation to Black and White."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. B. Tylor, "Animism as shown in the Religion of the Lower Races." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. W. E. Langdon, "The Employment of the Electric Light for Railway Purposes."

Civil and Mechanical Engineers, 12, Delahay-street, Westminster, S.W., 7 p.m. Mr. A. A. Myall, "Wire Net Making."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Joseph Pennell, "The Illustration of Books."

FRIDAY, MARCH 29...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Professor H. E. Armstrong, "The Structure of the Sugars and their Artificial Production."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. H. Law, "Principles of Calculating Areas, &c."

SATURDAY, MARCH 30...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Waves and Vibrations." (Lecture V.)

Journal of the Society of Arts.

No. 2,210. Vol. XLIII.

FRIDAY, MARCH 29, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Dr. D. Morris, C.M.G., delivered the second lecture of his course on "Commercial Fibres" on Monday evening, 25th inst.

The lectures will be printed in the *Journal* during the summer recess.

PRIZES FOR PHOTOGRAVURE.

[Attention is drawn to the two slight alterations in the conditions of the offer printed in italics.]

With the view of encouraging the development of Photogravure in this country, the Society of Arts offer the following Two Prizes:—

(1). A Prize of Twenty Pounds or a Gold Medal* for the best reproduction of a selected picture by a Photogravure process.

(2). A Prize of Ten Pounds and a Silver Medal for the best Photographic Negative of a selected picture, suitable for reproduction by a Photogravure process.

The following are the conditions of the offer:—

The offer is limited to British subjects.

The Committee have selected as a suitable test picture, Mulready's "Choosing the Wedding Gown," now in the South Kensington Museum, and the Lords of the Committee of Council on Education have kindly consented to allow the picture to be used for the purpose.

Competitors will be allowed to photograph the picture, which will be placed for the purpose in the Photographic Studio of the Science and Art Department.

* Should the winner of the prize elect to take the award in money, a Silver Medal will be given in addition to the sum of Twenty Pounds.

Competitors should apply to the Secretary of the Society of Arts, who will provide them with an order to photograph the picture, and will also see that the necessary arrangements for the purpose are made. Such applications must be received not later than the 30th March. A dark room is attached to the studio so that competitors can develop their plates on the spot.

Competitors for Prize No. 1 will be expected to send in a finished proof from the plate, the plate itself, and the negative from which the plate was made.

Competitors for Prize No. 2 will be required to send in the negative and a print from it. (This print may be in silver, carbon, platinotype, or other process.)

The negatives for both prizes must be taken on plates 12 × 10 inches, and the finished picture must be of corresponding size. The actual size of the original without the frame is about 21 × 18 inches.

The photographs and photogravures must be wholly untouched. Any work on the negative, *positive*, or plate will be held to disqualify the competitor.

The prints, plates, and negatives must be sent in to the Society of Arts not later than the 15th of May next.

The winner of Prize No. 1 will not be disqualified for Prize No. 2.

The taking of the negative, and the production of the plate, need not be the work of the same person.

The photographs, negatives, and prints will be returned to the competitors after the decision of the judges has been announced, but the Council of the Society reserve to themselves the right of exhibiting all or any of the works sent in.

The judges will be the Committee nominated by the Council:—Major-General Sir John Donnelly, K.C.B., Chairman of the Council; Sir Frederic Leighton, Bart., P.R.A., H. T. Wells, R.A., E. J. Poynter, R.A., Francis Cobb, Thomas Armstrong, Capt. W. de W. Abney, C.B , F.R.S., and Sir Henry Trueman Wood, Secretary.

The Council reserve to themselves the right of withholding either or both of the prizes, or of awarding smaller prizes, if they think it desirable to do so. The Council also reserve the right of declining to accept, at their discretion, any application for orders to photograph the picture.

The Council will not be responsible for any loss of, or damage to, works sent in.

TEN-VOLUME INDEX TO "JOURNAL."

The new Index to the *Journal of the Society of Arts*, for volumes xxxi. to xl. (1882-1892), is now ready, and can be obtained by members on application to the Secretary, John-street, Adelphi.

Some copies of the three previous ten-volume Indexes are still in stock and can also be obtained by members on application.

To non-members the price of each index is Half-a-crown.

Chicago Exhibition, 1893.

The following communication has been received from the Acting-Chairman of the Executive Committee on Awards of the Columbian Commission :—

World's Columbian Commission,
Executive Committee on Awards,
Washington, D.C.,
March 10, 1895.

Sir Henry Trueman Wood, Secretary, Royal British Commission, Society of Arts, John-street, Adelphi, London, W.C.

DEAR SIR,—In answer to your inquiry as to when the diplomas and medals awarded to exhibitors at the World's Columbian Exposition will be completed and ready for delivery, I would state that the Act of Congress of August, 5, 1892, made the appropriation for the preparation of the said medals and diplomas to the Honourable Secretary of the Treasury direct, and this Committee is therefore without responsibility in the matter until the same are delivered to us for distribution. The diplomas are being prepared at the Bureau of Engraving and Printing, and the medals are being struck off under the supervision of the Director of the Mint. We have been unofficially advised by the last referred to official that the medals will be completed about May or June next.

In considering the question of the time consumed in the preparation of these medals and diplomas, it should be borne in mind that the medals and diplomas radically differ from the stereotyped form of medals and diplomas which have been heretofore issued by expositions, in that each diploma granted to an exhibitor at the World's Columbian Exposition will contain a report of the individual judge as ratified by the Departmental Committee of which said individual judge was a member, showing the specific points of excellence and advancement possessed by the exhibit upon which such diploma is issued. Also the medal which will accompany the diploma will bear upon its face the name of the exhibitor to whom it is granted. Thus the diploma and medal will be unique and distinctive, and possess a higher and greater value than the stereotyped form heretofore employed. It is obvious that medals and diplomas of this distinctive character must consume more time in their preparation than the stereotyped form heretofore employed and in which such individual features are lacking.

Very truly yours,
(Signed) A. T. BRITTON,
Acting-Chairman.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday evening, March 19; J. HUNGERFORD POLLEN in the chair.

The paper read was—

PRACTICAL CARPET DESIGNING.

By ALEXANDER MILLAR.

When I read a paper on "Design in Modern Carpets" before this Society last year, I was obliged, for want of time, to omit that branch of the subject which deals with the practical application of design to the various fabrics in question, and I now propose to supply the omission. I am rather at a disadvantage in dealing with the subject, inasmuch as I have treated it somewhat fully in a section of the manual on "Practical Designing," edited by Mr. Gleeson White. But as the authorities of the Society of Arts—with a knowledge of that fact—have been good enough to ask me to read this paper, I make no apology for going over the same ground again, to some extent. It is not easy to avoid repeating one's self, but I shall endeavour, so far as I can, to treat the subject in a different way; to summarise such essential facts as must needs be re-stated, and to bring out more fully those which have been lightly touched upon, or altogether omitted.

Practical designing for any manufactured article must, before all things, have regard to the fabric in view, and the method by which the design is to be reproduced in that fabric. The designer should have in his mind a definite picture of so much of the method of manufacture as is concerned with the making of the pattern. No doubt it would be easy to draw

up a code of rules which, if properly adhered to, would enable the designer to dispense with this information ; but such a code, if unaccompanied by a knowledge of the facts on which it is based, must always wear more or less of an arbitrary aspect, and there is, therefore, great risk of its being grudgingly accepted, or ignored altogether. The artist is apt to think that the manufacturer's conditions are simply the outcome of his stupidity, his conservatism, his dislike to spend money, or some other undesirable quality peculiar to manufacturers. But when the designer sees for himself that the rules laid down arise out of ultimate facts connected with warp and weft, and so forth, and that they must be complied with, unless he is prepared to invent a new method of manufacture, he will, if he has the true artistic spirit, accept the inevitable conditions of his material, and set himself to work in harmony with them.

My main object in this paper is to give such information as to methods of weaving carpets as will enable a designer to see for himself why he must needs follow certain rules, if his work is to be of any practical value.

An intending carpet designer should, first of all, procure samples of the various fabrics he has in view, and get a thorough grasp of the method by which the design is produced in each of them. He should be so far familiar with the various grades as to say at once into which of the main classes, based on methods of manufacture, any given sample will fall. He should know the widths in which each fabric is made, the conditions which govern the repeat, the degree of fineness of the ruled paper to be used for each make and for each of the different grades of each make, the limitations with regard to number of colours, and in short all the conditions which are peculiar to each fabric. He will find out that some have severe limitations in the matter of drawing while they offer considerable latitude in colour, and that in others the reverse holds good, and he should be able to see at a glance why a design suited for one of these may be quite useless for another. It is utter waste of time to design for a carpet in the abstract as it were, or to imagine that when a design has been put upon ruled paper of some sort it has thereby become practical. Many, I may say most, of the designs which have appeared at South Kensington among the prize work year after year have seemed to be constructed on this vague *a priori* sort of principle, and it is really lamentable to see how much labour is wasted for the want on the part of the students of a little technical knowledge. If right relations existed between our national system of art teaching and manufacturers, prize designs would be sought after and their authors would have every chance of receiving lucrative commissions, but it must be said that in the matter of carpets this is the exception rather than the rule.

I fear that the conditions which are inseparable from carpet designing, and which I now propose to set forth in detail, may appear not only so irksome but so various as to cause an intending designer to despair of grasping them, but I would venture to remind any who may incline to this view that it is only necessary to fix the mind upon one class of carpets at a time, and that the facts which have to be kept in view for any one fabric are comparatively few and simple.

The methods by which a carpet pattern is reproduced in the loom are mainly five.

I.—The Oriental Knot.

The first is the Oriental knot, which in various forms is common to all Eastern carpets, and to those known as real Axminster in this country.

In designs for this class of fabrics the only limitations to be observed are those arising out of the degree of coarseness of texture. It should be remembered that the labour involved, and consequently the cost, increases, not in proportion to the numbers of knots per lineal inch, but in proportion to those contained in each square inch. Thus a carpet measuring 4 knots by 4 to the inch will have 16 to the square inch, while one 8 by 8 will have 64 or 4 times as many as the first. Therefore, on the ground of economy, if a given effect can be got by using the lower number, it is undesirable to use a higher. This consideration applies more to this make of carpet than to any of those which are produced wholly or in part by machinery. In the latter, as will be seen later, the extra cost of preparing a carpet of specially fine texture is greatly reduced, though by no means wholly removed, when a large number are made at one time, just as in the analogous case of a manuscipt copied by hand as compared with a large printed edition of a book, but in the handmade carpet the same labour has to be expended no matter how many duplicates of the original design are made.

In designing for this fabric therefore, its

cost, as thus affected by its fineness, should always be kept in view. In any case, as the price of hand labour in this country is high, the sale of such carpets must be comparatively limited, and the demand for designs correspondingly small.

In the matter of colour there is, in theory, no limit, but there are various considerations with which I shall deal later on, which make it desirable that the number of shades should be kept within reasonable bounds. The points of the ruled paper for this fabric are usually square.

II.—Jacquard Weaving.

The second class of fabrics includes all those which are produced by the Jacquard loom. I have not thought it necessary to write out a description of the Jacquard machine, which can be found in any text-book on weaving, but may briefly say that its action depends upon the use of cards, in which holes are punched corresponding to the squares on the design paper. By the action of wires, which pass or are prevented from passing through these holes, the appropriate threads of wool are raised to form the pattern. Carpets woven by this method are mainly of two kinds—first, that known as Kidderminster; second, the various fabrics made in the Brussels loom.

(a) Kidderminster Carpets.

In a Kidderminster, or, as I shall briefly call it, "Kidder" carpet, the method of forming the pattern is somewhat complicated. Both warp and weft have a share in producing the colour effect, the weft, the threads of which are much the thicker, playing the principal part, the warps having only a modifying effect. In its simplest form the fabric consists of two separate layers, or "plies," each forming a web complete in itself. They are woven simultaneously, and if there were no pattern they would remain two separate webs. But to form the pattern the threads which compose the bottom layer must be brought to the top, and *vice-versâ.* So where there is a change of colour there is a crossing of threads, which binds the two layers into one fabric. Consequently the more a pattern is broken up the more frequent these interlacings, and the more firmly the whole is bound together. Thus the designer has, to a large extent, under his control the very texture of the carpet with which he is dealing. He must avoid large spaces of plain ground, as this would mean loose baggy patches in the carpet. In self-coloured carpets, where the two layers or plies are nearly alike in tint, this does not matter much, as it is easy to bind the two plies together by numerous small stitches, which are not perceptible.

The way in which colours are used presents peculiar difficulties. While several bright and distinct colours can be used, it by no means follows that a brilliant effect is thereby produced. In the weft, which mainly forms the pattern, there may be four separate colours, but these must be used alternately, so that the effect is always that of a mixture. In this way many bright colours often entirely neutralise one another, and some interesting illustrations arise of the way in which colours are affected by mixture, that is, by the juxtaposition of small quantities without actual blending. Here the well-attested principle that mixtures of coloured light do not always produce the same result as mixtures of pigments is illustrated in a very instructive way. For instance, bright blue and yellow threads placed side by side do not produce green (unless either the yellow or the blue be somewhat greenish), whereas the same threads, if cut up into fine dust and mixed, will give a very fair green; on the other hand, some colours will give much the same effect in whatever way they may be mixed. I need not go into the reason of this paradox. The explanation will be found in any good manual of colour, such as Rood's "Modern Chromatics," and is briefly this, that blue, red, and yellow are not the true primaries.

A number of simple experiments are described in Rood's book, by means of which anyone can satisfy himself on this point. The rather washy and dull appearance of many Kidderminster carpets, even when composed of threads of bright colours, is entirely owing to this cause. When there is wide diversity in the coloured threads used, any combination of them is most likely to contain a certain amount of the three true primary colours, and the effect of such a mixture must always be more or less grey or dirty white. I am not aware that I have ever seen very successful effects produced by this method of mixing brightly coloured threads, though it is by no means theoretically impossible to get good results. But the colours seem to be frequently used in a haphazard sort of way, and I feel certain that it would be quite impossible for anyone without a thorough knowledge of the effect of the mixture of coloured lights to predict before-

hand what would be the effect of four untried shades, containing between them all the primary colours, in a Kidderminster carpet.

A study of the diagram (Fig. 1) will show what effects are at the disposal of the designer. With the arrangement there shown, out of four wefts, say green and yellow, red and black, he can get mixtures of GY, RB, GR, BY, but he cannot get GB or RY, as these threads cannot be on the surface at the same time. So his design must be composed in the main of masses, each made up of a mixture of two colours in alternate threads. He can get no solid mass of any tint. The colour effects of the weft threads are somewhat modified by the warp which crosses them, as the diagram will show. Any of the four wefts may be crossed by any of the four warps. Where green crosses green you get the effect of a solid green line, where it crosses a yellow you have a yellow line speckled with green. You will see that this opens up a prospect of complications far too difficult for anyone but an expert to deal with. My advice to designers for this fabric would be to confine themselves to simple effects, and to make their designs in two solid colours only. Mr. William Morris, who has done wonders in developing the artistic capabilities of this fabric, has, I think, altogether avoided mixtures of strong colour. If anyone should wish to try what can be done with them, he will find it very easy and interesting to make experiments by winding alternate threads of coloured wool round a large card, and viewing them from a distance.

At first sight, the fabric seems to offer considerable facilities for minuteness of detail in drawing, the paper used having 16 points to the inch in length by 8 in width. But this is largely neutralised by the fact that at the

FIG. 1.

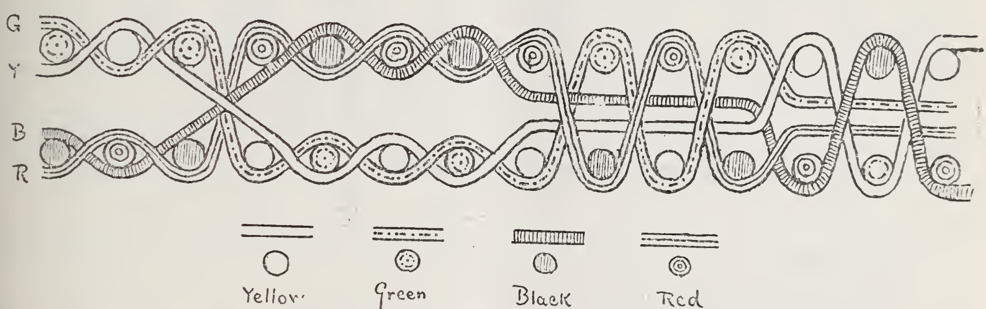


Diagram representing a longitudinal section of a Kidderminster carpet, showing how in one part there are two separate webs, which in another part are interlaced together to form one compact fabric. If the student will colour this diagram in accordance with the indication given, he will see the combination of threads out of which his colour must be composed.

sides the edge of any patch of colour is rather vague and sketchy, owing to the interlacing of the threads.

A superior variety of this fabric is made, in which there are three "plies," or separate webs. When strong, mixed colours are used, the effect is much the same as in the two-ply, and the mixtures are more complicated. But three solid colours can be got, with which very good effects are possible. Nothing but a study of the fabric will show a designer all its possibilities in colour, and he will do well to confine himself to three shades only.

(*b*) *Brussels Carpets.*

In a Brussels carpet the method of producing the pattern is entirely different, its only feature in common with the Kidder make being that the necessary raising of the threads to form the surface is done by the Jacquard machine. But while in the Kidder the weft plays the most important part, in the Brussels it entirely disappears from the surface, and its sole function is to bind the fabric together. The warp, of which the surface is entirely composed, is divided into two sections: the lower, which is of linen, unites with the weft to form the skeleton framework of the carpet; the upper portion of the warp consists of five layers, or frames, of worsted yarn, each of a different colour.

Here let me explain the meaning of some of the terms to be used. A "frame" means primarily the actual wooden frame in which the bobbins of yarn are mounted, from which the threads proceed to form a layer of yarn in the loom.

Secondarily, a "frame" means the layer

or stratum of yarn so formed, whether we think of it as at one level in the loom, or as lying now on the surface, and now below it on the finished carpet.

In the design a "frame" means that portion which is wholly formed by the colour corresponding to one of these layers.

A "planted" frame is one which is composed of longitudinal stripes of various colours.

The "plant" is the scheme according to which masses of colour corresponding to portions of these stripes, as arranged in the loom, are utilised in the design, and "planting" is the process of arranging these masses.

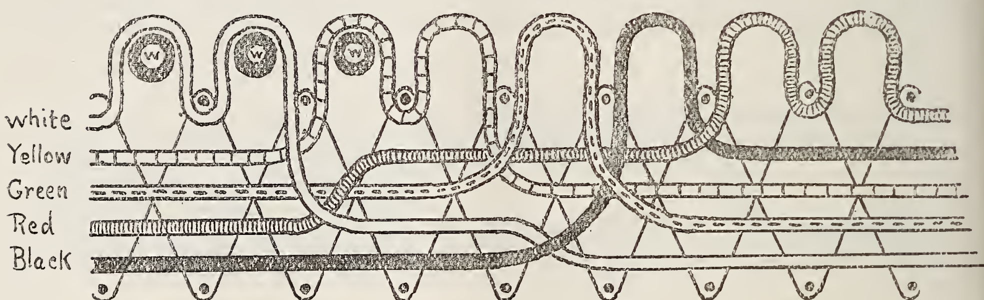
A "point" in a design on ruled paper is one of the small squares into which the pattern is divided, and which represents a loop or tuft in the carpet.

A "split" is one of the divisions between the warp threads which form the framework of the carpet.

A "shot" is a thread of weft thrown across the loom by a shuttle or otherwise.

In considering the method by which the pattern is produced in the loom, we may for the moment assume that each frame consists entirely of one colour. Between the warp threads which form the back there are open, longitudinal spaces or splits, and in each of these there are five threads of worsted, one out of each of the five frames. Any one of these threads—but only one at a time—can be brought to the surface.

FIG. 2.



This diagram represents a longitudinal section of a Brussels carpet, and shows how the coloured worsteds are successively brought to the surface to form the pattern.

www are the wires over which the loops are formed, shown in section.

The small black dots are sections of the weft.

The fine black lines are the "chain" warp, which with the weft forms the framework or skeleton of the carpet.

To follow the production of the pattern let us take one row of points across the design, and assume that the first point is black. By the pre-arranged action of the Jacquard, in the first space the black thread is raised high above the others and held there, the next square of the design may be red, so in the second space the red thread is raised to the same level as the black, and so on across the design. The number of spaces between the threads of the back corresponds with the number of squares across the design, *i.e.*, from 256 to 260. The lifting of all the threads takes place simultaneously, and the result is a particoloured layer of threads, one out of each space, raised high above all the rest. A wire is now pushed in from the side underneath this layer, which is then depressed, thus forming a row of loops across the carpet. A weft thread is then thrown across binding these in position. The threads which were raised having now fallen back into their place in the layers out of which they were lifted, another set of threads is raised in the same way, the selection this time being quite a different one, corresponding to the second row of the design, and so the process goes on automatically. (See Fig. 2.)

Suppose that it is desired to use more than five colours. This can be done by striping or planting one or more of the layers or frames. Obviously the layer so striped must be used but sparingly in the carpet, or the result will be an accidental stripe in the design. The right use of such a striped frame calls for the exercise of much skill and judgment. I think proficiency in planting will best be attained by, as it were, working back from the loom to the design. I advise the beginner to proceed as follows. Imagine that the five layers of worsted are underneath your paper, and that of these one is striped longitudinally. When you want

to utilise this striped layer you must use the colour which lies in the stripe over which you are working at the moment. Assume that this planted frame is a fixed quantity and that you must make the design to suit it, so that the whole colour scheme is fixed before you begin to draw. Suppose it consists of four neutral tints enlivened by touches of bright colour, and that the frame which is to provide this bright colour consists of stripes of blue, yellow, and red. To prevent too great a strain on the imagination it will be well to indicate the position of these stripes on your paper by faint washes of each colour. Then sketch the design roughly in, taking care that the forms (flowers or what not), which are to be brought out in the bright colours shall fall upon the stripes from which they are to draw their colour. Then finish the drawing of the design. Next fill in the flowers with bright colour. It will now be seen whether the planted frame has been used too freely. If so, stripes will show, and now is the time to prune. Avoid using in every case the whole width of the stripe, place one large flower to the right, another to the left; in any small intermediate sprays use only slight touches of the bright colour. Err on the side of using it too sparingly at first. If you have two stripes of the same colour in the width do not bring up masses of it in the same line across. If you have two flowers in a line, give one, say, a neutral centre with blue petals, and the other blue centre with neutral petals. If you want a spot of yellow in the centre of a blue flower you can very often get it by dropping out a few threads of the blue, altering your design so that they will not be missed, and substituting yellow at that part. Try to manage the touches of bright colour so that they will carry the eye thither and in a zig-zag line. Next fill in the all over colours. It will now be seen whether a few more touches of the planted frame may be used. In small quantities, blended with the neutral tints, they may have quite a different effect from that which they have in mass.

There can be no doubt that this plan of fixing the position of the plant beforehand is the best for the beginner. In fact it is generally quite useless to attempt to plant a design which has not been drawn with that end in view from the first. Of course the experienced designer can take more liberties, and can alter his plant and his design to suit each other as he goes on, with a full knowledge of the modification of the planting or striping that will be necessary to carry out his ideas.

I have hitherto assumed that the planted frame consists of a number of stripes of widely different colours. But this is by no means necessary or desirable. The stripes may be shaded or graduated from side to side to any extent. Theoretically no two threads need be alike, there might be the most delicate gradation from one side of the carpet to the other. In practice, adjacent stripes are often delicately shaded into one another. Red may insensibly merge into orange, orange into yellow, and so on. When this is done a flower, instead of lying, for instance, wholly in the red band, may be partly on that and partly on the orange. This is a great help in avoiding striping, as it evades the necessity of keeping all similarly-coloured flowers rigidly within the same band. When a frame is used in small quantities throughout the whole design, as, for instance, when it forms an outline or a thin stem, and is nowhere used in masses, it may be planted to almost any extent without fear of striping, provided that all the shades used have the same value and the gradation is delicate. Thus dark shades of olive, blue, brown, and red may be used almost indiscriminately instead of black in such a case, with good effect. Similarly a light outline may be tinted with very pale shades of various colours. This method is only applicable in the case of very light, very soft, or very dark colours, and by means of it an all-over frame may be converted into one richly planted.

In the practical selection of the yarns, it is not always easy to get perfect gradation, and in the case of an object lying upon two adjacent stripes there is the risk of an ugly line where the colours meet. Great care should be taken by the designer to prevent this. It can best be done by deliberately emphasising the difference between the two stripes so as to bring out the line at its worst. Then, wherever it can be done, a touch of another colour should be put in so as to hide the break as much as possible. A fault of this kind may be imperceptible in a soft quiet colouring, but may become very objectionable where stronger shades are used.

The problem of planting becomes rather complex when two planted frames are used. Here the method of indicating the position of the stripes by thin washes will not work, and another plan must be adopted. A strip of paper is taken, long enough to stretch across the design. This is painted to represent a cross section of one of the striped frames. A similar strip may be made for the second

frame, or both sections may be conveniently painted on the two edges of the same strip, which is called a "plant," or, sometimes, a "gamut." This, when laid across any part of the design, will at once show in what stripe of the planted frame any particular figure will fall. This is the plan in general use even where only one frame is planted, but I recommend the method first described, to the beginner, as more likely to fix in his mind the reason for what he is doing.

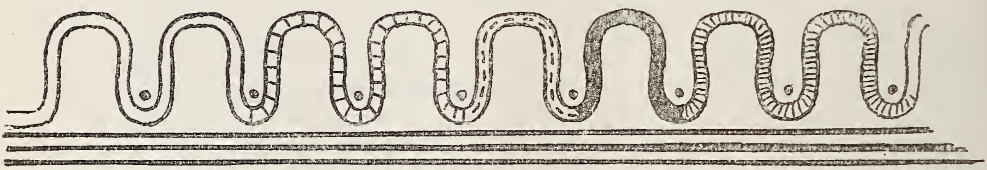
A simple method of using two planted frames is to use one composed of warm tints for flowers, and another quiet set of shades for leaves, with a dark outline for all, but not many patterns can be constructed on this plan. Usually the planting of two frames is much more complex than this, and when three are used, the proper handling of them taxes the power of the most expert craftsman.

The extent to which planting can be carried obviously depends upon the nature of the design. To take an extreme case, a pattern composed entirely of longitudinal stripes an inch wide, with a small pattern on them, might have five distinct colours in each, or 135 in a 27-inch wide carpet.

There is a point arising out of this matter of planting on which I wish to lay some stress. It is desirable that a design should be capable of taking as many different colourings as possible. In arranging the plant, therefore, the designer should never forget that in a Brussels carpet each colour is produced by continuous threads; therefore when a colour is changed in any part, it must also be changed in every other part which lies in the same longitudinal line.

Subject to this, changes in colour in a Brussels carpet can, to a limited extent, be made with great facility. To take a simple case, suppose a pattern has been woven in five shades of red, if another loom is ready with five corresponding shades of blue, it is only necessary to transfer the cards, by which the Jacquard is worked, from one loom to the other, and the thing is done. But if there has to be a special preparation of the loom, involving the tying in of some 1,300 threads by hand, the process is tedious and costly. On the other hand, it is very easy, by using different sets of cards in the same loom, to get any number of different patterns out of one set of frames of colour.

FIG. 3.



This represents the surface of a tapestry carpet, and shows how the same effect as in the Brussels is produced by a single thread, stained in sections.

The special limitations in the case of Brussels may be summed up thus. For the standard 5-frame quality no more than five colours can be used in a line lengthwise; in a 4-frame, four colours; and in a 3-frame, three. The ruled paper used has about nine points to the inch each way; 256 to 260 points in 27 inches wide is the standard. There is theoretically, no limit to the length of repeat, but it seldom exceeds 4 ft. 6 in., and is usually less.

In some cases six frames are used. This enables the designer to get a much richer effect of colour, but it involves a considerably higher price for the carpet.

The whole of what has been said as to Brussels applies equally to Wilton, Saxony, and several other makes of carpet, in which the pattern is produced in the same way.

The diagram on page 446 shows a longitudinal section of a Brussels carpet.

III.—Tapestry Carpets.

A "tapestry" carpet is, in fabric, very similar to a Brussels. Apart from pattern it is, in fact, simply a one-frame Brussels. The design is reproduced by a process of printing or staining the warps. The essential feature of the fabric is that each thread bears all the colours, being stained in sections of varying length, which, when the yarn is stretched out, are considerably longer than in the finished carpet, but which, when gathered up into loops formed by wires, exactly as in a Brussels, produce the design in its proper proportions (see Fig. 3). A single longitudinal strip of the design is treated at one time. A series of threads of worsted are laid side by side,

their number corresponding to the number of pieces to be woven. Assuming that one finds on the strip of design five points of red, a roller charged with that colour is run across all the threads until a section has been coloured of a length which, when gathered up in weaving, will form five loops, and so on with the other colours. Thus each thread of yarn becomes a duplicate of the first longitudinal strip of the design. A second strip is treated in the same way, and so on with all the rest. Then one strip is taken from the first lot, one from the second, and so on, and placed side by side in the loom. At this stage they form a reproduction of the design very much drawn out in length. They are then woven up into loops over wires, and so the pattern is produced in its proper proportions. From the method of staining the warp it follows that the colours more or less run into one another, and there is never the sharp boundary between colours that one finds in a Brussels, that is, looking at the pattern lengthwise. Between two adjacent colours, side by side, the line, however, is perfectly sharp. The blurring of the colours just referred to is the feature which distinguishes tapestry from all other makes of carpet, and it should be kept in mind by the designer, who will find it quite impossible to get sharp, clear contrasts in this fabric. On the other hand, this vagueness may be made to produce beautiful effects. I do not think the fabric is one which has of late received full attention from designers, probably because it has been so cheapened by competition, and its possibilities as an artistic fabric have scarcely been fully developed.

The points for a designer to bear in mind are that in a tapestry carpet the number of colours is theoretically unlimited, and that the number of points to the inch in the best quality is about the same as in Brussels. A design suited for a fine grade of Axminster will do equally well for tapestry.

IV.—The Patent Axminster or Chenille Method.

We now come to the fourth class of carpet fabrics, those which are formed by the process of chenille weaving, and which are known as Patent or Victorian Axminster. In this method there are two distinct stages, first, that by which strips of chenille are made, coloured to correspond with each row of points in the design, and, second, that in which the chenille so prepared is used as a weft in the final weaving of the carpet to form the pattern. These processes are carried out in two entirely distinct looms.

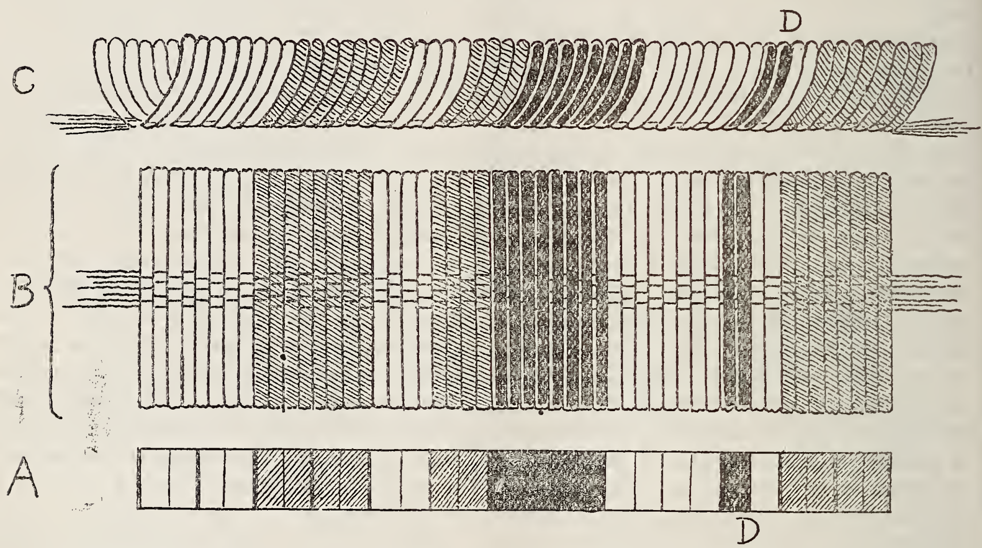
The design is put on ruled paper in the usual way, but the various papers used are very seldom ruled in squares. The spaces are almost always oblong, the squares being sometimes divided in half, while in other cases the proportion may be that of 6×8, 7×10, and so on. The reason for this will presently appear. It is important for the designer to remember that in every case the figure first named refers to the number of rows of chenille per inch in the finished carpet. Or, in other words, when the ruling of the lines is closer in one direction than another, the lines which are furthest apart are those which run across the carpet. If, to take an example, 6×12 paper be used, this means 6 points to the inch in the direction of the length of the carpet, and 12 in the direction of the width. In the carpet itself, it means that there will be six rows of chenille to the inch, but that in weaving the chenille beforehand, the colour may be changed every one-twelfth of an inch. This is a very great help in draughting the design, that is, putting it on the ruled paper; it doubles the fineness of the pitch in one direction, and thus permits of finer detail, without at the same time appreciably increasing the cost of weaving. The chenille fabric has in this respect a considerable advantage over all others. The ruling of the paper is very various, and ranges from 3×6 up to, in extreme cases, 16×16. Subject to what will be said hereafter, any number of colours may be used in the fabric, and it is possible to use a mixture of two or three different colours as one strand of yarn.

The design having been transferred to the ruled paper, it is handed, together with a number of shuttles containing suitable shades of worsted yarn, to the weaver of the chenille, who proceeds as follows:—His loom has a warp composed of a number of fine threads, not arranged in a continuous row, but in groups, with open spaces between. He cuts off from the design a cross strip, consisting of two rows of points, and lays this in the loom lengthwise, the end of which was on the left-hand side of the design being nearest him. He fixes his attention for the time entirely on the first row, and takes it as his guide. It begins, let us say, with six points of red. He takes up a shuttle containing that colour, and weaves it backwards and forwards, until his web has advanced as far as

the red extends on his strip of paper. He next finds on the paper four points of green, so he lays down the red shuttle, takes up the green, and proceeds as before. Suppose, now, that he comes to one point of yellow. Here will be seen the reason why the paper is sometimes ruled, *e g.* eight to the inch one way, while it is six the other. Yarns of various thicknesses may be used, and the number of shots must always be even, *i.e.* one across and one back, or multiples of these two. Suppose the yarn is of such a size that it will not conveniently lie closer than 16 threads to the inch. If each point is one-sixth of an inch, 6 will not divide 16 without remainder, so the 16 threads cannot be evenly divided among the 6 points. To avoid this, the paper is ruled eight to the inch, so that two shots fit exactly into each point.

When the weaver gets to the end of the first row of points, he turns the paper round, so that the end which was at the right side of the design is now nearest him, and proceeds as before, taking this time the second row of points as his guide. When he comes to the end of it he has traversed the two rows, the first from left to right, the second from right to left, and in doing so he has produced a continuous web,

Fig. 4.



This diagram shows how a design is reproduced by the chenille method. A is a strip of the design cut off crosswise. B is one of a number of identical strips of chenille woven to correspond with the strip of paper. C is the same strip of chenille which has been passed over a hot grooved roller, and has thereby had given to it a U shaped form as shown. It is now ready to be used as the weft in a second weaving in which it forms the pile of the carpet.

This is the process by which "Patent" or "Victorian" Axminster carpets are made.

It will be noticed that the squares of the design paper are divided into "half cords" or "points." At D it will be seen how advantage can be taken of this to get greater minuteness of detail in one direction, *i.e.*, across the design.

the length of which is equal to that of the two rows of the design. This web now consists of cross stripes of colour corresponding to those of the design, the effect being the same as if the weaver had cut the two rows of design paper apart, fastened them together by their adjacent ends, made a long strip out of the two, and used this as his guide. If such a strip were doubled back upon itself so that the two halves should lie flat side by side in their original positions, they would re-form the original two-row section of the design. And if the web be cut into longitudinal strips each of them will be a duplicate in colour of the paper, so if one of them be doubled back as the long strip of paper was, the section of the design will be formed in wool as it was by the strips of paper. As these two rows of the design are formed, so with all the others (see Fig. 4).

The web is next split up into strips by revolving knives, the cut being mid-way between the groups of warp threads before described. At this stage the strips are flat, and each consists of a backbone of warp with a thick fringe of short worsted threads at each side. To make them fit for the pile of a carpet, they are passed over a grooved heated cylinder, which turns up the threads at the sides, and

gives the strips a V or U shaped section. They are now ready to be used as the weft in the final weaving. (See diagram.) In this second process the loom has two warps and two wefts. The lower warp and weft together form a strong back. The upper weft is the chenille, which is woven to and fro on the back as the latter is formed, and is tied down to it by the upper warp which crosses it at close intervals. As it is placed in position row by row, the process is exactly analogous to the putting together of the cut-up strips of design paper, and the design is reproduced in the one case as in the other.

Let us now consider the chief points which call for a designer's attention arising out of this method of weaving.

First, from the fact that the fabric can be made of almost any size with any number of colours, and in any degree of fineness of pitch, it offers an unusually wide range for the designer. It is made in rolls of the usual 27-inch width, in rugs of all sizes, in wide strips for corridors, &c., and in carpets woven in one piece up to 10 or 12 yards wide and of almost any length. A carpet of this make was woven some years ago for the King of Siam, which measured 97 feet by 34 feet. But the designer should not forget that there are practical considerations which must be borne in mind, and to this end I return to the two rows of a design already described, with their corresponding strips of chenille.

Fixing our attention again upon these, which are a type of all the rest, it will be noticed that though a large number of strips, duplicates of these rows, may be woven at one time, only one of them can be used in its special place in any one repeat of the design; the others must be laid aside until the rest of the design has been finished and one of them is again required to fill its appointed place. It follows that the number of strips must correspond with the number of repeats of the design required, be that number large or small. And it is also evident that the greater the variety in the design, that is, the longer the repeat, the greater the length of chenille web which will have to be woven. To take a by no means uncommon case: suppose a carpet is wanted of a design in which the only repetition is that the two halves are alike (I refer now to carpets woven in one piece). Let the size be 15 feet by 12 feet, and the quality 7 to the inch, a very usual pitch. To produce such a carpet it would be necessary to weave a narrow web of chenille cloth containing only two strips of no less a length than 1,512 yards. But if 30 such carpets were wanted the only difference would be that the web would be wider, the labour of weaving it would be just the same; moreover as there are always two outer half strips which are wasted, the proportion these would bear to the whole might be in the case of the narrow web perhaps 50 per cent., while in the wider it may be 3 per cent. or less. When in addition to this we consider the cost of the original design, the expense of putting it on ruled paper and various other processes which have to be gone through, whether one repetition or 50 be required, it will be seen that the cost must be enormosly increased when the amount of repetition is small. I am disposed to lay great stress upon this point because I have observed that beginners very often make designs which cover a quarter of the whole carpet.

Another thing designers should bear in mind is that the value of a design for a carpet woven in one piece is much lessened when it cannot easily be adapted to rooms of various sizes and proportions. If the whole design must be put on lines afresh on a different scale for every carpet that is required the cost would be almost prohibitive. Such designs should therefore be arranged with as much repetition of parts as possible, and an increase or decrease in length or width should be thought out and provided for by the designer from the first. The more this can be done by repetition the less costly, and, therefore, more practically useful will the design be.

Then, as to the number of colours, though there is no theoretical limitation, yet the amount of extra time, labour, and expense incurred by a very large number should be realised. This is one of those practical considerations which meet the manufacturer at every turn, but which are liable to be overlooked by the designer. It is easy to multiply shades upon paper, but when each of these has to be dyed in varying quantities, it is a very different matter. I do not suppose it would occur to many designers that the mere selection and providing of the right quantities of the dyed yarns is a very serious item in the cost of manufacture, yet it sometimes takes a month or more to get this done for one pattern. There is, first of all, the calculation of the relative quantities of each colour of yarn required. There may be 50 per cent. of one, and only 5 per cent. of another with all possible intermediate proportions. A design is placed before the colourist, who is told the total number of pounds of yarn required to

make a given quantity of carpeting. She has to study the design and to determine, solely by observation and the use of her judgment, the per-centage of each shade that will be required. The greater the number the more difficult the task, and the greater the chance of error, which means waste if too much be provided, and delay if there be too little. And each new design is a fresh problem, on the solution of which those that have gone before throw little light.

Next, the yarns have to be selected, care being taken that there is a sufficient stock of each. Usually a large number have to be specially dyed, and as dyeing is a delicate chemical process, some little change in weather or temperature may cause some of the shades to come out not quite right. They must be dyed again and again, or sometimes the whole scheme of colour must be modified to counteract the error. I do not here refer to the matching of patterns which have already been made, in which, of course, no latitude is permissible. Altogether, no one who has not had experimental knowledge of it can understand what an amount of time, skill, and experience is needed for this little-thought-of department of manufacture. And every additional colour used by the designer adds to its difficulties.

Then as to the weaver. He has a different shuttle for every colour, and he must lay down one and pick up the next without a moment's hesitation. And be it remembered that in chenille weaving there is no mechanical contrivance for selecting the right colour at the right moment. It must be done entirely by the eye and hand of the weaver, so that his or her work is very far indeed from being a mechanical occupation.

Another consideration of an entirely different kind is that, if all the tints of the rainbow be used in the first colouring of a design, it is so much the more difficult to find other good and sufficiently different colourings for it, which makes it so much the less valuable, for the greater the number of good colourings that can be got out of a design, the larger will be its sale. Designers who are tempted to give way to the seductions of a *palette libre* should bear this in mind. A large number of the foregoing remarks apply more or less to all carpets in which there is no mechanical limit to the number of colours, although the special difficulties in each case may be different, and it is not necessary to particularise them.

Lastly, in designing for this fabric, the very wide range of pitch to which I have referred should be kept in mind, and the designer should have a clear notion for which of the different grades he is working, and whether for a seamless carpet or one woven in breadths 27 inches wide, and so on.

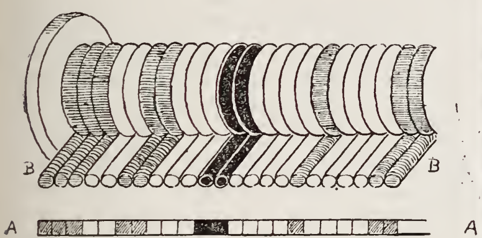
V.—The Moquette Method.

The fifth class of fabrics is that which may be generically described as "moquette." This name has become somewhat familiar of late through being associated with a low priced fabric imported from America, but it is the name by which the fabric was originally known in France, where it was invented, and I adopt it for that reason, and also because it is fairly descriptive, as the pile is inserted in "moquettes" or tufts, instead of being looped over wires or produced by chenille. The fabric as woven by a power-loom—invented in America—was first made in this country under the name of Royal Axminster, and other grades have since been introduced under such names as Albert, Aristo, Imperial, &c., all of these being made on the same principle.

The method of weaving may be briefly described as follows:—The design being put on ruled paper, a number of long spools or reels are prepared, one for each row of points across the design. To each of these spools a series of small tubes is attached, one for each point on the paper, a usual pitch being seven to the inch, or 189 for the usual 27-inch fabric. Suppose the first row on the design has six points of red, six threads of red yarn, drawn from bobbins fixed in a frame, are passed through the first 6 tubes, and their ends laid across the spool. If 4 points of green come next, 4 green threads are treated in the same way, and so on. When the end of the row is reached, there are 189 threads lying side by side on the spool, the width of which they exactly fill. This rather tedious process is entirely done by hand. The threads are now fastened to the spool by a simple arrangement, and it is revolved, winding up on it a length of all the threads sufficient for the number of pieces of carpeting required. The threads are now cut off, leaving a row of tufts projecting from the ends of the tubes, this row being an exact reproduction, in coloured wool, of the first row of the design. A similar spool is prepared for each successive row. Suppose the repeat to be a yard long, 7 times 36 = 252 spools will be needed. The spools are next fixed in the loom in an endless chain. As they

must be several inches apart, they occupy a very considerable space, a point to be kept in mind by the designer who may hanker after a long repeat. By the action of the loom, spool after spool is brought into position, presenting its row of tufts just above the spot where the framework of the carpet is being formed by warp and weft in the usual way. The tufts are seized by nippers, drawn out to a length equal to twice that of the proposed pile, they are then cut off and inserted by a downward movement of the nippers, each in its own split of the warp. A weft shot is thrown across to bind the tufts, they are then bent round this so that the two ends of each tuft come together, and a row of pile is thus formed, corresponding to the row of the design from which the spool was prepared. The next spool comes into position and the process is repeated. (See Fig. 5.)

Fig. 5.



This Diagram shows the essential portion of the process by which the design is reproduced in the "moquette" method of weaving. A cross strip of the design is taken (as in the chenille method). A "spool" is prepared, as shown above, by winding on it, side by side, coloured threads, each of which corresponds with one "point" in the design. The ends of the threads are left projecting through tubes, not shown in the diagram. A row of tufts is cut off from the projecting ends of the threads, and is inserted in the carpet as it is being woven, thus reproducing the original strip of the design. A series of similar spools complete the pattern.

It will be noticed that each "point" in the design is represented by a single thick thread, and not, as in the chenille method, by a number of thin ones. Consequently, in this process, there can be no subdivision of the points on the ruled paper.

The points for the designer for this fabric to keep in mind are, first, as to variety of colour, what has been said of the chenille fabric is equally true of this, except that in this mixture of threads is not so easy. Next, the design paper is usually square, or nearly so, $5\frac{1}{2} \times 5$, and 7×7 being, practically, the only sizes at present in use. Then, as to widths, nothing wider than 3 feet is made, and fillings are made only in 27 inches wide, consequently all patterns must be arranged for this width. Repeats should be as short as possible, as every inch added to the design means seven spools added to the chain.

Lastly, and this is an all-important point, in this fabric more than any other except tapestry, large quantities of each pattern must be made at one time. The laborious process of filling the spools by hand must be gone through, whether the quantity required be large or small. Once all the threads have been fastened to a spool, it costs no more to wind on a large quantity than a small one. Then, as only about $1\frac{1}{2}$ inches or so is cut off each spool for each yard of the carpet—supposing the repeat to be a yard long—therefore, a very few turns of the spool will wind up yarn enough to make a large quantity of carpeting. It is, therefore, essential that designs for this fabric must be such as will have a large sale; nothing can be made which, from its nature, will appeal only to a limited class. There is no chance for manufacturers to do what some of us do in other fabrics, viz., to bring out a certain number of designs of high character, without any hope of their being popular, and with a tolerable certainty of losing money by them. We do this partly for our own gratification, partly in the hope of educating the public to appreciate better things, and partly, let me say frankly, for the sake of *kudos*. But we cannot do so with this fabric. A large sale must be the first consideration. I am glad to say, however, that, to some extent, it is possible to secure this end, without altogether sacrificing artistic considerations. The intending designer will have to solve the problem of combining artistic and commercial success, by no means an impossible task. The main hope for the artistic treatment of this fabric is in those who have the ear of the public, and can educate it to appreciate better things. But there is no scope here for the "art adviser," who tries to justify his existence by suggesting alterations in every design that is put before him.

Time does not permit my referring at any length to other classes of carpeting, but I may briefly mention two. There is the large class of fabrics in which a certain amount of pattern is produced by twills and diapers, but these are what I may call weavers' designs, and though often exceedingly fine through their very simplicity, they scarcely come within the province of the designer proper.

Another class is that of printed felts, which I think have scarcely received from designers the attention they deserve. No fabric, it seems to me, is better suited to well-drawn

designs in two or three colours. I know nothing of the technical requirements, but I feel sure that there can be nothing that should stand in the way of artistic treatment.

I shall now venture to touch upon one or two aspects of the subject from its artistic side, though this does not strictly come under the head of "practical designing."

Subjects for Designs and their Treatment.

The questions, what are legitimate subjects for carpet designs, and within what limits is the right treatment of those subjects to be confined, are not easy to answer. Let us first consider why a carpet exists at all, and next, how it is used. In this country, at all events, it exists first for the sake of warmth, next for noiselessness, and lastly for comfort and ease apart from warmth. For all these ends it is desirable that it should be moderately soft; and though we should not be led away by a mere play upon words, there is, I think, sufficient relationship between softness to the touch, and softness to the eye in form and colour, to justify us in laying down the rule that a fabric which necessarily has this quality in its first sense should, by its treatment, suggest it in the other two. I know that many fine Eastern carpets directly violate this rule as regards form. They are often extremely harsh and angular in design, but this is amply atoned for by their colour, which in the best examples, however strong the contrasts may be, is always mellow and soft. And the angular geometrical designs are successful, not because they are angular, but in spite of their being so. This is very well seen in the magnificent work on Eastern carpets lately published in Vienna where nearly all the specimens are represented twice; in black and white, and in something like their original colours. Some, as shown in monochrome, are absolutely uninteresting, while others are in that form even more beautiful and suggestive to the designer, and, paradoxical as it may seem, to the colourist, than in the polychrome versions which purport to be faithful reproductions of the originals.

In the next place, as a floor is flat the decoration of its covering should be the same. It may seem strange that a carpet manufacturer should gravely enunciate a counsel of perfection of this kind, seeing that the bulk of the designs produced in this country do not comply with it. I need not repeat what I said in this place last year in explanation of the difficulties in which manufacturers find themselves owing to the necessity of producing what the trade and the public demand, and I only refer to it now to anticipate a possible charge of inconsistency between doctrine and practice. I must, however, refer to a particular class of cases in which we find ourselves in a difficult position if we are to insist on flatness as essential. I mean those in which carpets have to be made to suit rooms decorated in any of the French styles, say from Louis XV. to the Empire. It is expected that the style of the carpet shall correspond with that of the walls and ceiling, and as the characteristic features of the Louis XVI. style, for instance, are certain mouldings, scrolls, festoons, and so on, these have also to appear in the carpet. They can only be adequately represented by shading, and so flatness at once disappears, in addition to which we have the absurdity of hanging festoons, &c., on a horizontal surface.

Now in every respect, except in the all-important matter of flatness, such carpets answer their purpose admirably. I conceive that the ideal carpet for a Louis XV. or XVI. room with light walls is one with a simple design in monochrome for the filling, composed of two or three shades of a solid colour. It should be fairly dark for reasons of practical utility, and also because it gives a sense of solidity under foot, and acts as a foil and contrast to the walls. The border should, it seems to me, be treated as a connecting link between the walls and the mass of the carpet. It should, therefore, be somewhat light, and should unite within itself the colours of walls and floor, so that the eye may be led from one to the other without any unpleasant break. Now the method of shading lends itself admirably to all this. It enables us to get a filling which, though not absolutely flat in detail, has on the whole a level effect, and it is most admirably suited for the introduction of colour into the border. I have pondered much on the problem, how to introduce rich colour into the border of such a carpet, preserving perfect flatness, and at the same time retaining the characteristic features of the style, but can find no solution. It is easy enough to keep the filling flat by the simple expedient of using two shades only, but this to many eyes is tame and meagre, and it is less serviceable in wear than one with a number of tints. While I condemn shading I have strong sympathy with the feeling that underlies the craving for it, viz., the desire for gradation in colour. A clear sunset sky is more pleasing than the uniform blue of mid-

day, the myriad delicate tints of a tea-rose delight us more than the flat expanse of a camellia, and a piece of silk or velvet becomes much more beautiful when it is broken up into folds. In all these cases it is gradation that makes the difference. Now in other styles, notably in Persian ornament, it is very easy to combine gradation with flatness, but in the French styles it is almost impossible. If a very bold simple scroll be used as a filling, streaking may be tried, as in Persian work, but if this be done without an outline the design, so to speak, falls to pieces, and an outline gives a most objectionable hardness to a damask of this kind. If flatness be absolutely insisted on, there seems to be nothing for it but to put up with a filling in two shades, and as a border of the usual type would look intolerably bald and meagre if treated in the same way, I think the best plan is to reduce it to its simplest elements, and let it consist simply of a few well-proportioned bands with a broad, plain margin. This, of course, gives up the idea of making the border a link between floor and walls, but I can see no other way out of the difficulty. Some decorators evade it by using plain carpets, a solution more satisfactory to the manufacturer, as such, than to the designer. Possibly the Gordian knot may be cut in a different way. There are signs of a reaction against the French styles of decoration in favour of modern original English work. Already, both in Germany and France, the latter is rapidly making its mark, and I am glad to say that some of our leading dealers, who are also decorators, are using all their great influence in favour of purely English work.

It will be gathered from the foregoing that I have nothing whatever to say in defence of florid designs, in French and other imitative styles, so far as their drawing is concerned, though their colour schemes are often very fine, much of their beauty arising from the opportunities they offer for gradation.

Here let me interpose a suggestion that the use of simpler borderss would in many cases be an improvement. Mr. William Morris is reported to have said, "the smaller the room the bigger the wall-paper." In a similar spirit of paradox I am disposed sometimes to say, the bolder the filling the simpler should be the border.

In my last paper I referred to the introduction of graded and broken tints into English reproductions of Eastern carpets as a decided advance in colouring. Here, I find myself apparently at variance with Mr. Aymer Vallance, who, writing on carpets in the *Art Journal*, has said that "contrasted colours are rather to be preferred than subtle gradations of hue, which are apt to give the appearance of shading and relief, a thing always to be avoided in a flat surface. A bold and clearly-defined outline is desirable, and large patterns rather than small."

I am not quite clear to what Mr. Vallance refers. If he has in his mind those subtle gradations, which are not only "apt to," but are deliberately intended to give the appearance of shading and relief, I heartily agree with him; but his words, as they stand, have a wider range than this; and I wish to point out that—as some of the examples before you will show—gradation by no means necessarily involves the suggestion of relief, and moreover that a mass of colour may have subtle gradation within itself, and yet be, at the same time, in sufficiently strong contrast to adjoining masses. So that the two methods of treatment which Mr. Vallance regards as opposed to one another, may be combined with good effect.

I quite agree with him in condemning the imitation of errors and irregularities in Eastern carpets, when this is done in an obtrusive way. It is unpleasant to see the same mistake occurring with mechanical regularity every yard or so. But I defend the practice, not of copying mistakes, but of learning wherein the charm of such irregularities consists, and of applying the method in an unobtrusive way, so that the eye is pleased by variety and not offended by repetition.

Much might be written regarding Mr. Vallance's dictum on the use of a bold outline. I will only say that in practice many cases occur where the use of an outline is out of the question. His remark that "large patterns are more desirable than small" appears to be more an indication of personal preference than a statement which has any authority to support it. If all patterns are to be large, what are we to do in the case of small irregular rooms, landings, and so forth. This appears to me to be one of those cases where theory is apt to run wild for want of correction by practical work-a-day experience.

In selecting subjects for carpet designs, I suppose it will be generally agreed, whatever opinions may be held as to the desirability of copying and reproducing the work of the great ancient designers, that we cannot possibly do

better than to study their choice of subjects and their method of treatment, and to follow them in both respects so far as we find they have been successful.

Now, in their choice of subjects, we find that practically they have taken all nature to be their province. Their designs range from the simplest geometrical arrangements of knots up to ambitious representations of hunting scenes, and so forth. And we find that in many cases they are, up to the measure of their powers, frankly pictorial. It is not uncommon to see the same class of subjects treated in much the same way in illuminated manuscripts, in painted lacquer work, and in carpets. It will scarcely be contended that in choosing such subjects as cheetahs chasing antelopes they display that unerring artistic judgment with which they are usually credited. But their genius is shown by the triumphant way in which they have treated subjects apparently so unsuitable for the floor, and have brought out their decorative possibilities. The same may be said of their treatment of trees when there is an evident attempt to treat them in a naturalistic manner.

I cannot admit that they have never transgressed the bounds of what is permissible in subject, for they sometimes err egregiously. I cannot, for instance, imagine anything more atrocious than the two lamps hanging in opposite directions which disfigure the holy carpet at South Kensington. True, they are highly conventionalised, but the motive is unmistakeable.

In analysing even their most pictorial method we find that in the drawing there is the most absolute flatness. A spray or tree is laid out very much as one has seen seaweed spread upon paper. There is no foreshortening, stems rarely cross each other, and are rarely broken by leaves or flowers, but are frankly displayed, and often form a distinctive feature of the design. It has been said by a critic for whose opinion I have a high respect, Mr. Hugh Stannus, that in a carpet "the design should be of mass rather than line, and of leaves and flowers rather than stems," and while I quite agree with this as a general rule, as tending to give softness and repose, I think the success with which this rule has been disregarded in many fine Persian carpets shows that it is by no means without exceptions.

Here I wish to call your attention to three objects: first, a fragment, as its appearance indicates, of a very old Persian carpet, probably dating from the 16th century; next, a modern design, founded on English wild flowers, in which there is an attempt to treat them in the Oriental fashion; and, thirdly, a modern Oriental carpet in which much the same idea is carried out. The latter is possibly a copy from some ancient original, but I have not been able to trace it. I may say that the second design, suggested by the old fragment, was made long before I saw the third, and whatever may be thought of it, it will, at least, be recognised as an attempt to apply Oriental principles without copying Oriental forms.

I have tried, partly by way of a joke, and partly to show how right treatment may bring the most unlikely subjects within the range of what is permissible for carpets, to treat one or two pictorial subjects as we may conceive their being treated by a Persian designer. Of course I do not offer these as serious attempts at floor decoration, but I think they show that the range of possible subjects is wider than is generally supposed.

One thing I think the Persian designers have clearly shown, that in adapting natural forms we need not confine ourselves to those which are usually seen, so to speak, in plan. Some authorities have gone so far as to lay down the rule that only those plants which naturally assume a radiating form when seen from above, such as the daisy, the dandelion, &c., are suitable for floor decoration, that in fact only those plants which are found in the carpets supplied by nature are to find a place in those produced by art. This doctrine was very fascinating when first promulgated, and it is not easy to show that it is, theoretically, unsound. But in practice it has a terribly cramping and limiting effect, and it is refreshing to find that in the great masterpieces it is wholly disregarded.

One of the most beautiful types of the Oriental carpet is that in which the whole design consists of one panel, with a border, centre medallion, and corner pieces, the ground being sometimes plain and sometimes filled with ornament as in the Holy carpet, which is an excellent example of the type referred to. To my great regret I have to say that carpets designed on this plan find very little favour with the public at the present time. It may be remembered that I showed one last year, and considerable surprise was expressed when I said it was not a commercial success. The reason given me by a competent authority is that since the advent of the electric light, centre ceiling ornaments are no longer used, and carpets have followed suit. Intending de-

signers should, therefore, avoid this plan, tempting though it be.

Here I wish to point out that plagiarism of a legitimate kind seems to have been not unknown among ancient Persian designers. There is no other possible explanation of the fact that we find precisely the same motives as to general plan and details of ornament in leather book covers and in carpets, so much so that it is sometimes difficult in a photograph to tell at a glance from which of these two sources it was taken. It is certain that either carpets were founded upon book bindings, or bindings upon carpets, or that both were taken from some common source, probably architectural, the last supposition being the most likely one. I have known English designers to be convicted of copying on the strength of a much slighter resemblance than that which exists between these two classes of work. But whatever the explanation be, does anyone regret that the copying took place? Is not the world the richer for it? If the carpet man copied from the book, did he not put into the design that glorious colour in which the greater part of its merit consists, and to that extent produce something new and beautiful? And are not the endless variations which have been played on this same theme each of them more beautiful things than those which would have been produced by the same designers, if each of them had attempted to create a new type? Here is abundant justification, if any be needed, for the practice I adopt and recommend of going to ancient examples of other fabrics for ideas, both of form and colour. If one does not merely copy slavishly, but puts something of ones own into the design, one has acted on the lines on which all the great decorative work in the world has been produced. And when I say "something of one's own," I do not necessarily mean an absolutely new conception. (I very much question if any such thing exists, but I must not stray into metaphysics). If a designer takes a subject from one source, a method of treatment from another, and a scheme of colour from a third, and combines them into a harmonious whole, he has made something new under the sun, and probably something very much better than anyone could have produced entirely by his own inventive powers, great geniuses always excepted. The faculty of combining two or more apparently unrelated ideas, and of evolving from them something which is not a mere piece of patchwork, but has an organic unity of its own, is, I hold, distinctly creative in character. As Mr. Gleeson White has happily said, "adaptation is the true originality."

It is odd that the manufacturer is never blamed for taking his colour wherever he can find it. And yet it is by far the most important element in a carpet. Why then should he be permitted to borrow and adapt his colour, while he is blamed for doing likewise with his forms? The only answer I can find is that those who blame him do not sufficiently realise the enormous importance of colour in relation to carpets.

Suppose the Persian designer had the suggestion made to him by a friend, "There's a nice book cover; wouldn't it make a capital carpet." If he had indignantly repudiated the idea, and insisted on being absolutely original, his work would not have been what it is. Those who think otherwise should be able to point to some absolutely new piece of ornament the parentage of which cannot be traced to some pre-existing form, a somewhat difficult task.

Let me not be understood as advocating the practice of borrowing from contemporaries, though few can avoid being at least influenced by them. But sometimes, in this respect, a manufacturer may be blamed without cause. A designer sometimes carries out the same idea for makers of two different fabrics, with the full knowledge and concurrence of both. For instance, I show you Mr. Arthur Silver's "Sea of Flowers" cretonne, and the same idea carried out in a carpet. It is about as unsuitable for the latter purpose as a design can well be, but Mr. Silver is not responsible for suggesting the misuse of his charming conception, which was adapted by him for a carpet to meet the taste of a foreign market.

I am sorry to say, also, that the practice of selling the same design to two manufacturers, without the knowledge of either, is not unknown, though it is more common among French designers than in this country.

Hints to Beginners.

Let me now say a few words to guide the beginner in the actual making of a carpet design. He will, of course, first decide on a particular fabric, and keep his attention closely fixed on the conditions which apply to that alone. In most cases, I think the easiest plan is to make a sketch quarter full size, but if the designer finds in himself a tendency to over-elaborate his details, a still smaller scale should be adopted. A small sketch offers facilities for the necessary copying out and

laying together of several repeats, and its adoption will avoid what will seem to many the drudgery of working on ruled paper, but, nevertheless, a portion at least of every design should be carried out in full size on the special paper adapted for the fabric in view. The enlarging process is much simplified by the division of all ruled papers into squares by heavy lines. To enlarge it is only necessary to make a tracing of the small sketch, divide it into corresponding small squares, and proceed in the usual way. This is the only way to see what is practicable, and to avoid multiplication of details, which is the fault to which most beginners are liable. Care should be taken not to run into the opposite extreme, which involves unnecessary clumsiness of drawing. When the designer has acquired the knack of making a small sketch or "model," as it is called, which contains nothing which cannot be satisfactorily put on lines, he need trouble himself no more with ruled paper. The great mass of the French designs, which are so thoroughly practical, are made quarter full size on plain paper. I cannot but think that the facility thus offered may attract artists who are now repelled by what to them is the tedious irksome process of putting on lines.

Ordinary water colours should not be used except for a rough preliminary sketch in which the scheme of colour may be arranged. Body-colour, that is, powder or distemper colours ground up with gum or size, is the only satisfactory medium for carpet designs. I have heard of a case in which an art teacher insisted on his pupils using water colours mixed with white, but this method is quite unsuitable. It is absolutely necessary in a carpet design that every tint should be perfectly solid, level, and distinct. There must be no unevenness, and no insensible gradation between one colour and another. It should never be forgotten that each tint used has to be translated into a separate shade of yarn, and the design should be such that it is possible to count without doubt or hesitation the number of distinct tints employed. Every mass of colour, whether it be a large space of ground or a tiny dot, must be sharp and well-defined, as much so as if it were cut out of coloured paper and laid on, but of course this by no means implies that there may not be very soft gradation produced by a series of tints.

If an outline be used, it must be remembered that on the ruled paper its minimum width is fixed by the size of the "points." In a Brussels it cannot be less than one-ninth of an inch, and in Axminster it will be still broader; therefore, great care should be taken to obliterate all pencil lines, lest, if they be allowed to show, a mistaken idea be formed of the way in which one colour tells against another. If designs with light and shade be attempted, the methods of French designers should be closely followed, as they have a marvellous knack of getting effects of this kind in body colour, and of indicating the modelling of a scroll or a flower by a few bold simple touches, which is exactly what is wanted for a carpet. In work for coarse fabrics harsh contrasts should be avoided. Much can be done to decrease coarseness of effect by soft gradation of colour, a point which Mr. Aymer Vallance has probably not considered.

As to the size and arrangement of designs, for tapestry, Brussels, and Axminster woven in breadths, it may be noted that fillings are invariably made 27 inches wide. There is no fixed limit for the length of the repeat, but it should be as short as is compatible with the avoidance of striping. In Kidderminster carpets fillings are made a yard wide, there are generally two repeats of the pattern in the width, and 2 feet is the usual length for the repeat. In Brussels and Axminster the pattern should invariably be what is known as a "drop," but in Kidders it should be what is called a lift over or self match. In borders the repeat need not be the same as that of the fillings in length; 18 and 22½ inches are the usual widths.

In planning a design the artist should try to form a mental picture of what the effect will be when a large number of repeats are seen in diminishing perspective. Balance and distribution should be carefully studied, long straggling lines and angular forms should be avoided, and stems should be broken and disguised by leading other stems in an opposite direction, or by throwing a spray of flowers across them. As a rule bi-lateral symmetry should be avoided. It frequently leads to great practical difficulties, as when narrow irregular corridors have to be arranged for. It will be found that a carpet which has a great deal of intricacy and mystery is more pleasing than one of which the whole scheme can be seen at a glance. In the drawing of the design this quality can be obtained by the use of a complex system of stem work, not by any means necessarily an obtrusive structure, but one which will carry

the eye hither and thither, aud will not yield up the whole secret of its construction at the first glance. It can also be obtained by adroit management of colour, for instance by the use of different ground shades, that which forms the ground in one part becoming the figure in another, and so on ; in fact there is no end to the complicated arrangements which are possible. A study of everyday commercial designs is the best means of mastering these. Whatever their artistic faults may be, some of them are marvels of ingenuity in this and other respects.

I can quite understand the feeling of repulsion with which our leading designers turn away from them, but I venture to suggest that they are sometimes worth study for their technical qualities, their arrangement, the way in which difficulties of drawing are got over, &c.

Newspaper Criticism.

In my last paper I referred at some length to the prejudicial effect exercised upon the standard of designs in British carpets by the tone of such references to them as are made in the public Press. There has recently been a glaring instance of this, to which I hope to be excused for calling attention. Referring to a correspondence on the subject of the exclusion from this country of foreign-made goods, the *Evening Standard* recently had an editorial paragraph, which concluded as follows :—

"Regarding Indian prison carpets, it may be observed that the most of them are of size and quality which private manufacturers do not touch. Assuredly they work no harm to British trade, unless it be argued that the householder, who pays £50 for an article, exquisite in pattern, of purest dye and honest make, would despairingly buy a horror from Kidderminster at £20, if the Indian article were refused him."

It would be difficult to say whether the ignorance or the animus of the writer is the more conspicuous in this paragraph. His ignorance is obvious in his statement as to the relative size and quality of Indian and British carpets ; and both ignorance and unaccountable venom underlie the implication that it is impossible to find an English carpet which is "exquisite in pattern, of purest dye, and honest make." It is really monstrous that an irresponsible scribbler, sitting in that coward's castle, the editorial chair, should be permitted to rattle off a statement of this kind, which would be unworthy of notice, were it not for the fact of its appearing in such an important newspaper. It has just sufficient superficial smartness to make it dangerous, as it may influence that large section of the public which likes its mental food cut up into convenient morsels, and does not enquire too curiously as to their wholesomeness, so long as they are highly seasoned

I do not think I can better show the utter fatuity of the words I have quoted than by placing beside them the following quotation from Sir George Birdwood's book on "The Industrial Arts of India."

"Unfortunately, there has lately been a great falling off in the quality and art character of Indian carpets [so much for the *Standard's* "exquisite pattern, purest dye, and honest make"], partly, no doubt, owing to the desire of the English importers to obtain them cheaply and quickly, but chiefly owing to the disastrous competition of the Government jails in India with the native weavers.

"Formerly the native weaver strove his utmost to produce a work which would prove a pleasing picture, knowing that the payment he would obtain for it would depend upon its beauty of design and superexcellence of fabrication; but now his first thought is to reduce his work to the charges ruling in the European markets. The natural result is seen in a comparison of the old Indian carpets with those now made in these countries, to say nothing of the mongrel manufactures of the jails in India. The staple is so short, and the texture so loose, that they will not bear the wear and tear of a middle-class English house."

If these words should meet the eye of the *Standard* writer, I think he will admit that, as Mr. Whistler has said, "A little paragraph is a dangerous thing."

There is just enough of truth in the expression, "a horror from Kidderminster," to give a certain plausibility to the allegation. No one can say more forcibly than I have done, that of many carpets produced in and out of Kidderminster the description is fair enough. The injustice lies in the implication that all English carpets are artistically of the same class, and that they are as dishonest in quality, as they are bad in design and colour. A very little inquiry will prove that in Kidderminster and elsewhere in Great Britain, some carpets, at all events, are produced which, though inferior to the great masterpieces of the past in design and colour, are infinitely better in all respects than much of that which is now produced in the East, and which, in spite of the faults so graphically described by Sir George Birdwood, is bought by an unthinking public

influenced by ignorant and superficial *litterateurs*.

To conclude, I have now, to the best of my power, tried to put in the possession of any designer who may wish to turn his attention to carpets all the technical information which will enable him to make his work of practical value. I have by no means exhausted the subject, but I have endeavoured to impart such knowledge of it as I have been able to acquire, in the earnest hope that when designers know exactly what to do, more artistic effort may be turned in the direction of floor decoration, and that I may thereby attain the fulfilment of my strong desire to see the manufacture of British carpets becoming more and more of a true art industry.

I feel that in what I have said on the artistic, as distinguished from the purely practical side of the question, I have trod on debateable ground. I may be rebuked for my presumption, and proved to be entirely in the wrong. I shall not be greatly concerned if I can attain my main object of arousing an interest in the subject, and I shall cheerfully give up my own ideas if I can be shown a more excellent way. But I think that my views are at least entitled to so much weight as may be claimed for them by one who has spent a great part of his life in thoroughly exploring a narrow and little frequented backwater of the great stream of applied art. I hope that by bringing designers face to face with practical requirements, I have shown that we manufacturers are not so unreasonable in our demands as we may sometimes appear. May I hope that I have also shown that some of us are at one with artists in their loftiest ideals, though we feel, to quote Mr. Gilbert, that it is hard "to long for whirlwinds and to have to do the best you can with the bellows; to yearn for the undefinable and yet to be brought daily face to face with the multiplication table."

During the reading of the paper a number of models, samples of carpets in different stages of manufacture, &c., were shown; also sections of designs showing the same subject carried out for different grades of carpet, illustrating the modifications of form and colour necessary in each case; among them was a portrait of Mr. Gladstone on fine, medium, and coarse ruled paper. This was shown to illustrate the point that the amount of detail must be in proportion to the texture of the fabric. Mr. Millar had intended to give some practical illustrations of various points, but was obliged to omit them from want of time.

DISCUSSION.

The CHAIRMAN said they were much indebted to Mr. Millar for this most interesting paper, and especially for the clear explanation he had given of the various mechanical operations connected with the carpet manufacture, which he for one had always found it very difficult to understand. The hints given to designers were also very valuable, and would no doubt be carefully studied.

Mr. WALTER CRANE expressed the pleasure it had given him to hear this most practical paper, which raised many points which would require a good deal of thinking over. He could not atttempt to traverse the whole field covered by the paper, but with regard to two striking designs on the wall, of sporting subjects, he did not know whether he was right in attributing them to Mr. Millar himself, but he understood him to offer them as a rendering in modern English of what the ancient Persian did in his carpet, and from that point of view they were a little open to criticism, if they were offered seriously. They certainly did touch a rather important point of design, and he quite sympathised with the view that more meaning might be put into designs. Undoubtedly the Persian in his carpet did produce things that he cared for, and Mr. Millar's hint about English wild-flowers was certainly noteworthy. They were too much limited by the historical pattern-book, and a man was asked to work in a certain style whether he knew or cared anything about it or not. It would be much better if they tried to draw out what the designer really enjoyed doing, especially if they wished to build up anything like a national school. The Persians certainly were very fond of hunting and also of gardens, and therefore flowers, animals, and men hunting constantly appeared in their designs; but, as a rule, in treating animals, they did it on the heraldic principle. If they drew a greyhound or antelope, there was no mistaking the animal represented. In the case before them, the greyhound was very severely foreshortened, and might possibly be mistaken for a lizard, or some such animal. The essential principle in representing animals was not only to design them so as to contribute a varied and pleasing mass of form and colour to the pattern which could not be attained in any other way, but to remember that the animal must be distinctly characterised. Still, the greyhound—as a decorative design—was, he thought, more successful than the other (the huntsman and five-barred gate). The use of the horizon was fatal in a thing in a design intended to be placed on the floor; and there was a certain sense of perspective in both designs which was out of place in a carpet. The carpet representing the City arms afforded a subject which the ancient Persian would have revelled in, and he would have produced something admirable; but this was a tame, washed-out thing, which, as he understood, Mr. Millar rather apologised for bringing. There was no reason

why those elements should not be made striking and interesting. He was glad to hear Mr. Millar pronounce against the use of shading in carpets as indicating relief, which seemed quite out of place in anything to be trodden on. No doubt many people would like to have the opportunity of trampling on Mr. Gladstone, but that design was not much shaded. The third specimen, which was the roughest, being made on three points, was the most effective, and the exhibition of the three renderings was rather an instructive lesson in decorative design as to the degree of emphasis necessary, which resolved itself into a question of distance from the eye. He was glad to hear so favourable an opinion expressed as to the likelihood of revivifying English taste in carpet designing, but whoever went into this branch of art could not help looking back to the ancient Persian as the most interesting and beautiful type; they need not imitate him in his design, but they must follow him in principle.

Mr. Lewis F. Day said he should like personally to thank Mr. Millar for his most practical paper. It was just what was wanted—he did not know when he he had heard a paper so entirely to the purpose. Nothing could be better than the ingenious devices adopted by Mr. Millar to explain to the outsider the technical processes of carpet weaving. Anyone who had ever tried his hand at describing a technical operation knew how difficult it was, but Mr. Millar had succeeded perfectly in making himself understood. Mr. Day felt quite safe in saying that, because it had all been made quite clear to himself—than whom no one could well be denser when it came to understanding a mechanical operation. With Mr. Millar's theories about design he agreed almost entirely. Mr. Millar had suggested that he (Mr. Day) would probably not approve of certain carpets on the wall in which the pattern was in relief. As carpets to be walked upon, he certainly could not condone them; but as fabrics they wanted no apology; they suggested to him very beautiful material for wall-hangings and the like. *Apropos* of the different "grades" of Axminster carpets on the walls he would like to know the relative cost of producing them. It seemed to him, from where he stood, that some of the coarser "grades" were much the happier in effect; he thought manufacture often went too far; we should do better sometimes by attempting less. He quite agreed with Mr. Millar that there was no need to confine oneself in carpet design to daisies and such-like radiating forms; to suggest that we should was mere bigotry. With regard to the variety of colour in, say, a conventional scroll, he did not quite see Mr. Millar's difficulty. It seemed to him quite possible to get any amount of gradation, without in the least suggesting relief—that, of course, was what had to be avoided. *Apropos* of "Oriental plagiarism" it was not plagiarism; the fact was all design was then traditional, and patterns were repeated over and over again; those happy Orientals lived in times when nobody ever thought about originality. Nowadays designers were continually plagued to produce something new by—should he say manufacturers?

Mr. W. G. Trewby, in reference to the complaint that the carpet manufacturer was not consulted as to the decoration of the room in which his carpet was to be placed, said there was one notable instance in the opposite direction. When Lord Clive returned from India, he brought a splendid carpet with him, and in building Claremont he instructed the architect to design one room especially for the carpet.

Mr. Matthew Webb said he should like to suggest a question in relation to the matter of Eastern carpets, and the principle of radiation and pictorial treatment—not as to whether the principle was right or wrong, but whether the Eastern carpet could really be taken as a precedent. He thought it was a question whether those Eastern carpets, especially the older ones, were not more often made for wall decoration than for use on a floor. It was undoubted that they were used in that way, and pictorial treatment would therefore be more appropriate.

The Chairman then formally proposed a vote of thanks to Mr. Millar, which was carried unanimously.

Mr. Millar, in reply, said he had been agreeably surprised to find that his views met with so little opposition, and it had been a source of great gratification to him that some of them had been confirmed by such eminent authorities as Mr. Crane and Mr. Lewis Day. He must say, however, that he was somewhat taken aback to find Mr. Crane seriously criticizing the two sporting designs on the wall, after what he had said about them. The idea had occurred to him at the last moment to illustrate the point that a very wide range of subject is permissible if the treatment be right, and, by way of a joke, as he had explained, he took two sporting subjects from the illustrated papers, and without altering the drawing, had treated them as he conceived a Persian designer would have done. He did not propose to put anything of that kind forward as a serious suggestion for carpets, but he did think they showed the possibility of somewhat enlarging their range of subjects. As to the City arms, it was the City architect, or some such official of thirty years ago, who was responsible for the design; the makers simply had to carry it out, and it was exhibited only for a technical purpose, to show what an enormous amount of labour was necessary, when a thing of that kind had to be produced, in one example only. With regard to the growth of a demand for English designs, he was glad to be able to say that it was in a large measure due to Mr. Crane's own efforts. He knew that was so in Berlin,

for the exhibition of his works there had created quite a *furore* for English decorative art; and a number of German decorators had been over here, trying to get hold of anything approaching the same style; he had also had applications from Frenchmen for specimens of *le style Anglais*, and had seen one or two French attempts at the same thing. He did not quite agree with the remarks of Mr. Day as to the easiness of getting gradations of tint in a scroll without shading. If you took a flat scroll—a very big one—you might manage to get a certain amount of gradation by streaking and clouding; but his experience was that, in attempting to do it without outline, the design seemed to fall to pieces; perhaps, however, it had not been done in the best way. As to the plethora of new designs, and the desire for originality, by which manufacturers profited—or suffered, as the case might be—he did not quite follow the argument, that the designer was plagued by the manufacturer. The manufacturer did not want to go to such great expense, and to keep a staff of nearly 150 at this work. If he could keep his looms going without all that, he would be glad as a manufacturer, though perhaps as something of an artist, he might take a pleasure in producing works as beautiful as he could. The manufacturer did not want to bring out a large number of new designs every year; it meant that the old ones, which were often perfectly good, were thrown aside, and he had to be continually on the strain looking out for something new. The case mentioned by Mr. Trewby was hardly applicable to English carpet manufacturers, though he knew of one instance in which a room was specially prepared for a fine English carpet. In ordinary circumstances, however, not only was the room built before the carpet was made, but the wall papers and decorations, and everything in the room was chosen first. In one case he knew of, two rooms were furnished in two entirely different schemes of colour, but as it was desirable sometimes to throw open the folding doors, and use the two rooms as one, a carpet was demanded which should harmonise with both. He was not an authority on the question of ancient Eastern carpets being used as wall decorations; he knew they were often seen on the walls of museums, and thought that was the best place for them, for they were too precious to be placed in any other position, but he did not think that was the purpose for which they were originally intended. But even taking it that Mr. Webb was right, and that they were made for walls, he did not think they were always suitable for that position. Some of these carpets with hunting scenes had the same subject repeated in each of the four quarters, and the same animal, which had its feet pointing down in one corner, had them pointing up in another. In any case, whether made for a wall or a floor, the hanging lamps in the holy carpet were absolutely indefensible. The only case in which he could imagine their both appearing in their proper position would be when the carpet was hung across a pole for the purpose of being beaten. In conclusion, he said that if in any respect he had failed to make himself understood, he would be glad to give further information or explanations to anyone who might communicate with him.

Mr. A. Silver writes:—I should like to make reference to Mr. Millar's remarks on the students' works exhibited at the South Kensington Museum. It is very obvious that if medical students were to be trained without the advantages of hospital practice that we should have a sorry race of doctors to attend us; similarly, if our art students in the decorative field have been trained, as seems apparent, without the aid of practical demonstration, then I venture to think this is one reason for the low general standard of design in carpets. I yield place to no man in interest in the decorative arts, and therefore I feel more keenly when I see so large an amount of original capacity lying as it were on a dust-heap for want of practical knowledge. I venture to think that remedy would be found, if a wise method of co-operation were established between practical experience and theoretic teaching, and that gentlemen who, like Mr. Millar, possess in their various fields extensive practical knowledge, united with a sincere desire for the progress of our decorative arts, should be invited by the authorities to contribute their experience alternately, or otherwise, with other lecturers, in the training of our art students. I do not believe a general standard of design will be reached except by some such combination. We are progressing favourably, though very slowly, and we have achieved some victories, but these victories are the soldiers' victories and not the general's.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 27, 1895; George Davison in the chair.

The following candidates were proposed for election as members of the Society:—

Bevan, Rev. Cecil M., 38, Orsett-terrace, W.
Coode, John Charles, 19, Freeland-road, Ealing, W.
Duckenfield, Edwin Ernest Vernon, Gold-street, Northampton.
Hesketh, John, Osbourne-road, South Shore, Blackpool.
Skinner, John, 57, Jermyn-street, S.W.
Yule, Andrew, 19, Great Winchester-street, E.C.

The following candidates were ballotted for and duly elected members of the Society.

Adams, Henry James, 13, Salcott-road, Wandsworth-common, S.W.
Bell, Joseph, Messrs. Barlow and Jones, Limited, 2, Portland-street, Manchester.
Williams, Llewellyn, Coolgardie, Western Australia, and Cardiff Castle Gold Mines, Limited, 1, Queen Victoria-street, E.C.

The paper read was—

MODERN PHOTOGRAVURE METHODS.

By Horace Wilmer.

If I take a piece of polished metal, such as I have in my hand—copper, for instance—and draw a design upon it, and then remove all the metal round and about the design, so as to leave the latter standing up above the general level of the copper, we shall have in its simplest form a typographic block. Such a block, when mounted on a piece of wood so as to bring it what is called type-high, can be inserted amongst type; can be printed simultaneously with letterpress, and constitutes the basis of the illustrations which we see in books and newspapers. The various methods by which such blocks are made may be described as relief processes, because in them the design or picture is in relief.

If, on the other hand, I take this same piece of copper and, instead of drawing and designing upon it as before, I scratch with a sharp instrument, such as a graver, a series of lines, I have in its simplest and most elementary form an engraved plate. Such a plate is no longer capable of being inserted amongst, and printed simultaneously with, type. It requires a different class of ink, different paper, and a different press in which to take off the impressions.

From the earliest days of photography it has been the constant endeavour of experimentalists to utilise the photographic image for the production of printing blocks, and during the last half-century many important inventions having this end in view have been made.

It is not too much to say that at the present time, in regard to book and newspaper illustration, photography is almost exclusively used in the construction of the printing blocks, while in its more pictorial and artistic aspect, *i.e.*, in the manufacture of etched plates, it is now largely doing the work which at one time was exclusively the province of the etcher or engraver.

The title of my paper, which is that of modern photogravure processes, will not allow me to linger any further over the subject of modern relief processes, fascinating as it is. The field covered by these processes, the enormous advance which has been made in them during the last few years, and the influence which they will have on the future of journalism, are subjects of the very deepest interest.

I have already pointed out that the method of printing a photogravure, or engraved plate, differs essentially from that of a relief block; and it would be well, before describing how such plates are made, to familiarise you with the appearance of a photogravure plate, and to describe to you the method in which it is printed.

In printing an engraved or etched plate, such as a photogravure plate, the plate is slightly warmed. It is then dabbed over very thoroughly with a stiff ink, known as copperplate ink, until the plate is completely covered, and exhibits nothing but an uniform black surface. The printer then proceeds, with the assistance of a large roll of muslin, and working with a circular motion, to remove all the ink from the surface of the plate; he finishes it by working it with the palm of his hand, and having carefully cleaned the margins with chalk, it is ready to print. It is now placed face upwards on the plate of the press, a piece of paper of special quality—which has been damped and kept under pressure for a time, so as to make it moist throughout—is laid upon it, and the plate and paper are passed through the rolls of a press. The pressure of the roller, which is very considerable, is distributed over the back of the paper, by the interposition of several thicknesses of fine and coarse blanketing. The paper is lifted gently off, and we have now an impression in ink, in thickness corresponding with the actual depths of the various parts of the picture. The picture is really a cast in stiff ink, showing in varying thicknesses of ink the varying tones of the picture.

Briefly speaking, this is the method in which an intaglio or photogravure plate is printed, and the method applies to every form of engraved plate, whether produced by photography or otherwise.

You will no doubt have imagined to yourselves, from what has been described, that the surface of a photo-etched plate consists in a number of depressions, deep where the heavy shadows are, less deep in the half-tones, until we reach the level of the original copper, which represents the high lights.

To a certain extent, this is correct; but were it absolutely true, the making of a photogravure plate would be a much simpler matter than it really is. Such a plate, however, would be useless, because it would not yield a print at all, and for this reason: the surfaces etched are large; the depths of etching are extremely small, and so also the difference

between the depth of the tones. The consequence is that although it would be easy enough to cover such a plate with ink, the roll of muslin would inevitably wipe out all the ink again from these shallow depressions. It is therefore necessary to break up, by some means or another, the whole surface of the plate, so as to form not only large areas of shallow depressions, but to cover these portions with a series of honey-combs, or cells, which shall imprison the ink and resist the tendency of the muslin to sweep it out.

The means by which these cells or honey-combs are formed are called the grain, and the matter is one of the deepest importance, because the success of the resulting picture, the superiority of one process of photogravure over another, depends very largely indeed on the question of grain.

There are many methods in which a grain is imparted to a plate. Its action consists in protecting the copper, wherever it exists, from the action of the etching fluid. The etching goes on amongst and around the grain, but wherever the small particles of grain exist, a small pinnacle reaching to the original level of the copper is maintained, and thus forms the honey-combs or cells described.

No half-tone intaglio plate can be printed at all unless it possesses a grain of this sort. An artist's etching, with which you are all familiar, is composed of lines entirely, and these lines being deep and narrow, there is no tendency of the muslin to wipe out the ink. In the case of a mezzotint plate, however, a grain is given by means of a rocker. The plate is, previously to its being worked, pitted all over and in all directions with a toothed instrument known as a rocker, so that, if inked up, it gives one uniform black impression: the half-tones and high lights of the picture are afterwards put in by means of a burnisher and scraper.

You will see, in the diagram which I now show on the screen, the appearance of a photogravure plate if it were prepared without a grain. The second picture shows a plate which has been grained with the picture over it, and the third a typical section of an etched photogravure plate.

I also show on the screen a slide exhibiting the actual grain itself. In the process which I am about to demonstrate to you, the grain is given by allowing a very fine dust of bitumen to settle all over the plate. The plate is then treated sufficiently to attach these tiny particles to the plate, and they protect the copper wherever they exist from the action of the etching fluids.

In order to get the finest results from photogravure it is obvious that we ought to have the means of etching as deeply as we can in our deepest shadows, but in doing so a practical difficulty comes in. In proportion as we etch deeply so we etch laterally, and if the etching is carried beyond a certain point a danger arises of carving away the summits of these important little pinnacles of grain on which the whole success of the printing depends. The coarser the grain is in the first instance the less is the danger, but inasmuch as the beauty and delicacy of a proof depends on the grain being as fine as possible—because each of these little points prints as a white speck—it is clear that the ideal grain is one which shall be graduated in coarseness, in proportion exactly to the depth of etching which it is to represent. That is to say, we require to produce the finest results, a discriminating grain coarsest in the deepest shadows, finest in the highest lights, and graduated throughout the picture, and I shall presently refer to certain methods in which a discriminating grain forms part. This question of discriminating grain is one to which a great deal of experimental work has been devoted.

The question of grain, generally, is of so much importance that it dominates all other considerations. Every advance and improvement that has been made in connection with the methods of intaglio work have depended upon this special factor. In the editorial article of the *British Journal* Almanack of 1893, Mr. Traill Taylor puts the matter very clearly. He says:—

"In truth the subject is of great importance, for whereas it is by no means difficult to convert a negative having lights and shades into a surface having such lights and shades converted into reliefs and hollows, it is not always easy to impart to a printing surface of this nature such a degree of granularity as on the one hand will hold enough ink as to enable a good impression to be obtained therefrom, or on the other hand to give it so pronounced and coarse a grain as just stops short of destroying all the fine details. Large industries and vested interests depend upon this matter of grain, to the successful selection or application of which several firms are indebted for their eminence."

The possibility of utilising the methods now in vogue for the production of screen negatives appears to be of special interest in this matter,

and indications are not wanting that perhaps in the near future transparencies broken up by means of a screen might be used and an artificial grain obtained by these means.

There are many methods by means of which photogravure plates can be made. The Klic process, of which I propose to give a practical demonstration later on, is, owing to its simplicity and the results which it gives, very largely used both in England and all over the Continent. You will see round the walls examples of work by several English as well as Continental firms, and I have no doubt that many of these are done by the process in question. Briefly speaking, in the Klic process a transparency is employed, and a print from this is made on carbon tissue. For the information of those who do not know what is meant by carbon tissue, I will explain that it is paper coated with a solution of gelatine containing bichromate of potassium. This salt invests the gelatine with the extraordinary property of insolubility after exposure to light. If, therefore, paper so coated is exposed under a negative or transparency, the gelatinous film is rendered insoluble, in proportion to the intensity of light action, and when it is soaked in warm water, owing to the dissolving away of the portions unaffected or less affected, a picture in relief is obtained in which the shadows are either depressed or elevated, according to whether a transparency or a negative has been used.

In the Klic process, the copper plate is grained, the carbon exposed picture is mounted on its surface, and, after development and drying, the picture is etched by means of perchloride of iron. There is no means in this instance of giving a discriminating grain.

A method described by Bonnet in his book, "Manuel d'Héliogravur," published by Gauthiers-Villars and Company, of Paris, and which, with some modification, I have worked myself, consists in the following:—A copper plate is coated with the bichromatised gelatine solution and dried over a heated surface, by means of a whirler. It is then exposed under a transparency, and, after exposure, is developed in warm water. When it is considered to be sufficiently developed, because no image is visible, I soak it in a solution of Judson's violet dye, and this will bring out the picture. It is then grained over the film, after it is dry, and, in the first instance, a somewhat coarse grain can be given. The picture is then etched, the shadows will be first attacked, and, after a certain time, the etching is arrested, and the film is cleaned off. The whole operation is repeated, and a finer grain given, when the etching is carried somewhat further, and, for the third time, the grain given is very fine, and the etching carried to conclusion. Careful methods of registration are required. You will see that in this case a discriminating grain is rendered possible. The process, however, is much more tedious than the Klic process, but it contains the germs of success.

The methods to which I have referred consist in the etching direct of a copper plate, through a photographic picture previously mounted on its surface. There is, however, another class of methods, which consist in building up a plate upon a relief by deposition of copper in a battery. Colonel Waterhouse published some 15 years ago a method of doing this. A gelatinous film, which has been exposed under a negative, and in which, therefore, the portion representing the shadows are raised, while the high lights are depressed, is sifted over, while still wet, with sand. The sand is prepared previously, by heating it with wax, and stirring it until cold, so that each grain of sand is enveloped in a coating of wax. The grains of sand sink more deeply into the thick parts of the gelatine picture and less deeply into the thin parts, so that when the film is dry and the sand is brushed out, the picture, as represented by the film in relief, is pitted all over with a grain, coarse in the shadows, and getting finer as it approaches the high lights. The film is then rendered conductive, by brushing over with plumbago, and a copper cast is formed by it in a battery. The cast forms the photogravure plate.

There are many other processes other than those I have mentioned for the production of photogravure plates, and I would refer anyone interested in the subject to the editorial article of the *British Journal of Photography* for 1893. I am indebted to the excellent description, given there by Mr. Traill Taylor, for such information as I do not possess from practical knowledge.

I should like to take this opportunity of congratulating this Society on their action in offering certain prizes for the encouragement of photogravure in this country. The world has been largely indebted to the efforts of an Englishman, Mr. Fox Talbot, for the advance in the methods of producing photogravure plates; and it seems strange that at the present moment the English market should be supplied almost entirely by Continental pro-

ductions. The works of Messrs. Goupil, the Berlin Photographic Company, M. Dujardin of Paris, Dr. E. Albert of Munich, Paulusen of Vienna, and others, are to be seen everywhere, but, up to the present, English firms have hardly entered into the arena, in spite of the magnificent paintings in our national collections waiting to be reproduced.

I propose now to proceed with the demonstration of the Klic process of photogravure.

The negative selected for reproduction should be as perfect as possible ; but inasmuch as a reversed transparency is required, it is usual to make this by means of the carbon process. The tissue known as transparency tissue, and sold by the Autotype Company, either in a sensitive or unsensitive condition, is the best to employ.

I prefer to purchase the tissue in its unsensitive condition, and sensitise it myself as required. This is done in a 3 per cent. bath of bichromate of potassium, and the tissue is then dried on plate-glass in a drying-box. The ventilation of the box should be such that the tissue will dry in about five or six hours. The negative is masked, and the tissue exposed and printed. The exposure depends, of course, on the density of the negative, but it is generally somewhat long, owing to the large quantity of pigment contained in the gelatine. The tissue is mounted on glass and developed, and, when dry, is masked in the same way as the negative.

The picture, which is to be mounted on copper, and which is to form the resist through which the etching takes place, is also printed on carbon tissue, but in this case we use either one of the ordinary brands of carbon tissue, such as the standard brown or the purple, or, in preference, a special tissue made by the Autotype Company, and known as autogravure tissue. This is printed under the transparency, and, in order to ensure as correct an exposure as possible, a trial print is made and mounted on matt opal glass. An inspection of this after development will show if the correct exposure has been given. The picture is of course negative in character, having been produced from a transparency.

The copper to be used should be manufactured out of specially good metal, be highly polished, without flaw or scratch, and should be bevelled. Such plates can be obtained all ready prepared, and cost about 1d. per square inch.

The plate is cleaned by means of a soft pad of prepared cotton wool, moistened with a cream of double-washed whiting made into a paste with water containing a little dilute ammonia. The solution should not exceed 5 per cent. in strength. The plate is cleaned by circular rubbing. The whiting is either washed off or wiped off with cotton wool, and it is well to put the plate into water containing a few drops of sulphuric acid, say one drachm of acid to one pint of water. Wash and dry the plate, and it is ready for graining.

The grain commonly used is powdered bitumen, although any gum which can be reduced to a very fine powder and which will resist the acid is suitable. Powdered resin can be used, and it has been recommended to use a mixture of resin and bitumen, but since the plate has to be heated and these gums melt at different temperatures there is a difficulty in fixing them both on the plate, at least by heat.

A box containing the grain, such as you see here, is revolved slowly in order to set all the dust in motion. The sides and top are well struck to detach any particles which may adhere, and which would cause trouble by dropping on the plate while in the act of graining. The box, after 15 to 20 revolts, is brought to rest, and allowed to rest for a time before the plate is inserted. The period of rest determines very much the character and coarseness of the grain. The heaviest particles fall first, and if the box is allowed to rest for say one minute before the plate is inserted the grain will probably be pretty fine, but a few experiments will soon show. It is allowed to remain in for some three or four minutes, and is then removed. The plate, it should be said, should be inserted in the box resting on a glass plate larger than itself, and be supported a little above the bottom of the box.

Probably one graining will be insufficient, and it will be necessary to repeat the process perhaps twice before enough grain is on the plate. It is well, when first starting the process, to put on a fairly large quantity of grain, so as to be sure of not running a risk of biting away the grain. The plate is now nipped in a handvice or pliers, and heated over a gas flame until the grain is heated, and has tacked itself on to the plate. This occurs when the plate appears when looked down upon to have lost all its grain, and when examined by reflected light with the eye low down appears a steely grey. The plate is allowed to cool, and the negative carbon resist previously described is then mounted

upon it in the ordinary way. When mounting the tissue allow it to soak very thoroughly before squeezing it on to the plate.

After it has been squeegeed put a few sheets of blotting-paper over it and a heavy weight and allow it to rest for a quarter of an hour or twenty minutes, more won't hurt.

It is then developed in water at about 100° F., the temperature of the water being raised to 110° F. while the back is stripped off. Develope thoroughly so as to get rid of all insoluble gelatine, and then allow it to dry spontaneously or else dry off by methylated spirit.

When it is thoroughly dry, and this is an important point, it is ready for the margins. The marginal lines are ruled with an ordinary engineer's pen, charged with stopping - out varnish, and the edges and back carefully painted.

The plate is now ready for etching. The mordant consists of perchloride of iron. It is used in solutions of varying strength determined by means of a Beaumé hydrometer. The solutions generally used range from 43° Beaumé, being the strongest, to about 30° Beaumé, being the weakest, and some five solutions of strength, say, 43, 40, 38, 34, 30, may be used. When first made up the solutions acts too energetically, and the older they are the better probably will they work. Anyhow when you get a set of solutions that are working well you may look upon them as valuable. It is well to add, say, 5 per cent. of methylated spirit to each solution. It works then with greater regularity. The action of the etching is as follows :—The negative resist, which is on the copper plate, consists of varying thicknesses of gelatine. In the shadows the film is extremely attenuated, in the high lights, it is at its thickest.

A solution of perchloride of iron, graduated to 43° Beaumé, can only penetrate the very thinnest solution of gelatine. If we start therefore with this it will, provided the film in the deepest shadows be sufficiently thin, commence to penetrate and attack the copper underneath. It is left for, say, one minute after the etching is commenced, when it is poured off and the next weaker solution used. This having greater penetrating power will attack the next tones, while at the same time it cumulates the etching in the deepest shadows—and so on each solution as it is put on, bringing out fresh detail and at the same time increasing the work done by the previous ones. The total time of etching will vary from ten minutes onwards, but the exact time which each solution is allowed to act depends on a variety of considerations, and the exact knowledge can only be acquired by practice. It is a good rule to allow each solution to act so long only as it finds out and brings out fresh detail so soon as its action appears to cease. and it appears to be only etching downwards instead of onwards, it is time to go on to the next; the last solution will bring out the sky, and the picture will apparently blacken all over. It is then time to take it out and plunge it into a bath of potassium carbonate and water. This converts the perchloride into carbonate, and the film can be well rubbed off with the finger. The plate is then well washed, dried, and cleaned off with benzole, which will remove the bitumen. Follow this with turpentine on cotton wool, then a little methylated spirits applied in the same way, and, lastly, clean with the weak ammonia solution and a little of the whiting cream. Use it very thin, so as not to rub down any of the fine detail, wash the plate and immerse again in the weak acid, as at first, and your plate should be then ready for printing.

A little dry whiting rubbed over the plate with the finger will adhere wherever ink will, and will give you some idea of the printing value of your plate.

I have also to express my best thanks to a number of English and Continental firms who have been kind enough to come forward and lend me specimens of their work for exhibition to-night. To the Autotype Company, of Ealing; the Swan Electric Company ; Messrs. Walker and Boutall ; Mr. Dawson, of the Typographic Etching Company; and amongst Continental firms, Monsieur P. Dujardin, of Paris ; the Berlin Photogravure Company; and, last, Dr. Eugène Albert, of Munich. The latter gentleman informs me that he was the earliest worker of photogravure on the Continent. Messrs. Penrose and Company have been very kind in lending me some apparatus, and I desire also to thank my friend Mr. Malby, who has given me valuable assistance this evening.

DISCUSSION.

Mr. Leon Warnerke, when called upon by the Chairman, said he had nothing to say, for everything had been so thoroughly and clearly explained, that it would enable anyone to work the process without difficulty.

Mr. W. BOUTALL said there was one matter on which he should like to say a few words, which had been alluded to in the paper, and another which had not been mentioned. The first point was the suggestion for utilising in photogravure the same kind of screen as was now used for relief work. To this there were two or three objections. In the first place, they knew that its use was interfered with by the texture of the original painting or drawing from which you were working, and in its turn the screen operated, so as to modify or destroy that texture; secondly, he doubted very much if it would be possible to obtain a satisfactory screen sufficiently fine for use by this method; and, thirdly, assuming these two difficulties to be got over, it seemed to him there would be a great objection on the score of the monotony which would be imported into the result. So far as relief work was concerned, a screen was useful, because you had to create a printing texture which could be used in a typographic press; but that was a much rougher mode of printing, dealing only with the surface of a block. Copper-plate printing allowed of more refinement and delicacy than any process of relief printing, and therefore he thought there would be a loss rather than a gain if they abandoned the charm and delicacy due, in large measure, to the irregular reticulation produced by the accidental deposition of points over a plane surface, such as was given by bitumen or resin, and there would be no compensating advantage in the uniform reticulation which a screen would give. Another point was that such a screen would have to be used in combination with the negative, and that he thought would be fatal. The other matter on which Mr. Wilmer had not touched at all, was the amount of retouching or additional work beyond that due to the mere photographic reproduction which a plate should receive. Theoretically, it was possible to make a perfect plate by means of photogravure alone, and by careful steel facing to obtain impressions from it, but in order to obtain a really satisfactory printing plate, which could be handed over with confidence to a printer to handle as he chose—and very often he handled in a fashion which the maker would hardly approve—it was necessary to proceed rather farther in the direction of biting than would be necessary where only a few impressions were required. This opened up a very large question with regard to the reproduction of subjects which were in colour in the original, and it seemed to him absolutely essential that in such cases a certain amount of retouching should be allowed. You had to obtain the translation of colour into monochrome; you could get it to a certain extent by the orthochromatic process of photography; but that did not get rid of the difficulty entirely; you only had a translation, and probably you would get certain values, and have to ignore others. In such a case, some working up of the plate was necessary; there were other cases in which slight accidents might occur, arising, perhaps, from purely photographic defects, not sufficiently serious to spoil the plate altogether, but which would be serious blemishes if not removed. The paper, as a whole, had been most interesting, and the demonstrations very satisfactory.

Mr. W. ENGLAND asked if any of the gelatine was washed away when the picture was placed on the plate.

Mr. WILMER said yes, it was developed in the ordinary way.

Mr. E. G. SHEPHERD asked if the solution was neutralised before etching.

Mr. J. CODD inquired how many prints could be obtained satisfactorily from such a plate as had been produced.

The Rev. F. C. LAMBERT asked if any explanation could be given of those difficulties which every beginner experienced, which were known as "devils" or craters. He had made a point of inquiry about this of every one who had any experience, and found great differences of opinion on the subject. He had been experimenting himself, and had formed a sort of provisional theory, but it was still very hazy, and he should be glad to know if Mr. Wilmer could throw any light on the matter.

The CHAIRMAN said this process was known by a great many names, such as photogravure, autogravure, heliogravure, and photo-etching. The subjects touched upon by Mr. Boutall were very interesting, but he believed the use of ruled screens in connection with an intaglio process was not not only practicable, but had been actually carried out. A short time ago he was examining some photogravures, and was a little puzzled to notice a peculiar but not very conspicuous cross-line appearance all over the picture, and could only come to the conclusion that it had been produced by the use of a line screen. But on examining it with a microscope, he also found a grained appearance, and, therefore, believed they were produced by a combination of the bitumen grain and a ruled screen, and he did not see any difficulty in such a use. This was a subject on which Mr. Warnerke might, perhaps, have given them some information; and he might also have told them something of his own intaglio method of using silver salts instead of chromium salts, a silver paper being squeegeed down upon the copper instead of a carbon tissue. He would ask Mr. Wilmer whether he ever adopted the method of rolling up and re-biting, and if he had had any difficulty from the film splitting off the plate. With regard to re-touching plates, there was a great deal to be said for it from a commercial point of view, but photographers certainly ought to aim at getting

a process which was capable of turning out perfect work without any subsequent touching up of the plate. Any such work must vitiate the result, to a certain extent, as a rendering of the character of the original picture. Orthochromatic methods, he thought, would meet the difficulty of rendering a picture in monochrome almost to perfection. Of course little differencies of colour would occur, but after all the photographic representation would be found to be more true (if it were measured scientifically) than the best hand-work in black and white.

Mr. WILMER, in reply, said he had never had any difficulty with films leaving the plate, but he knew that many workers had; for instance, Mr. Denison, of Leeds. He attributed it to the fact that he dried his carbon tissues in a room, whereas he (Mr. Wilmer) always used a drying box, where they did not take more than five or six hours. It was not possible to dry the tissue in a room in so short a time. He had not said anything about re-biting, but no doubt in the hands of a professional man this power was one of great value. If the grain would stand re-biting there was no difficulty in increasing the printing power of the plate and improving it very largely in that way. Whether the Chairman included re-biting amongst the objectionable manipulations of the plate he did not know, but probably there were few plates met with in commerce which were not re-bitten. With regard to "devils" they were the bane of every photogravure worker, and he did not know any one who had not been worried by them at one time or other. They consisted of deep cavities, sometimes round, but often the shape of a star fish, mostly in the deep shadows, but sometimes all over the plate, which, of course, printed black. He had not been so fortunate as Mr. Lambert, in being able to formulate any theory as to their origin; he could only say that he knew pretty well, by a sort of intuition, when he was going to get them and when not. There were certain cases in which he thought he had been able to trace the cause, to a certain extent; that was when he was using plates which had been cleaned and polished a second or third time. Mr. Ernest Edwards, the President of the New York Photogravure Company, had a good deal to say about devils, and had evidently formed a theory about them, but strange to say, the chief etcher of the firm was of exactly the opposite opinion. Mr. Edwards told him they never got one on an ungrained plate; the chief etcher thought it was caused by the solution becoming acid, and whenever he found an inclination to produce devils, he put a little iron in to rust it up a bit. He did not think any complete explanation had yet been given. Such a plate as he had produced might give 50 or 60 impressions without being seriously damaged, but as a matter of fact, professional workers hardly dared take a proof impression off a plate without having it steel-faced; and it was certainly not advisable to print more than two or three before that process was gone through. The solutions were neutralised with oxide of iron in order to destroy the acidity of the perchloride of iron. As the solutions got older, and had been used more and more, the liability to develope "devils" decreased. They were put into a large enamelled saucepan, and the oxide stirred in and allowed to simmer, and then filtered. In addition to that he added about 5 per cent. of methylated spirit, which resisted the action of the acid, and prevented it attacking the film so rapidly. With regard to re-touching, he agreed with the Chairman. As an amateur, he had not the opportunity of re-touching, or doing the fine work upon the plate that professional etchers had, and he should like to see a law passed that no hand work should be allowed on a plate under any circumstances. With regard to the reproduction of works of art, where fidelity was most important, certainly retouching ought to be the least possible; in producing an original picture he did not see why any method should not be adopted which would enable the finest result to be obtained. With regard to the use of a screen, he threw out a suggestion which he meant to be as vague as possible; but he had had the opportunity of inspecting plates which had been produced with the aid of a ruled screen, but he did not know exactly the circumstances, or whether the screen was used in combination with a grain on the plate as well he was not able to say. It certainly was not very obtrusive.

The CHAIRMAN then proposed a vote of thanks to Mr. Wilmer, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

RUSSIAN WATERWAYS.

Several important canal projects are at present under consideration in Russia, where the necessity of increasing the means of communication is being more and more realised. One of the most important schemes is that of connecting the White Sea with the Baltic by means of a canal, which will be about a hundred and sixty miles long. There already exists a waterway ten feet deep about half of this distance, and this only requires deepening. The Neva River forms the Lakes of Ladoga, and Onega, and Swir between the two. The canal would proceed from the Onega Lake, at the town of Pouzeny, situated at the end of the lake, then follow the Pouzeny River to the Lake of Langen, which lies at the water boundary between the Lake of Onega and the White Sea, then cut through the Lakes of Matko, Telekino, and Wyg, and finally, through the River

Wyg, reach the White Sea. A recent German review says that this plan is not altogether new, but was under discussion as far back as 1870, when the Minister of Commerce drew attention to the vast importance a waterway of this kind would possess. A plan for a canal about thirty feet deep was also, at a later period, proceeded with, but the matter was allowed to drop. Last year the Government, however, ordered it to be taken up again; some preparatory work was done, and the cost of the canal was calculated at ten million roubles, or £1,500,000. Another still older project is the bringing about of a connection between the Black Sea and the Caspian Sea. However important such a waterway would be, there is one drawback, namely, the fact that the Azov Sea, which is bound to form a link in the chain, is only navigable for vessels up to fifteen feet draught. The connection between the Black and the Caspian Seas can only be established in two different manners. According to one plan, the Volga would be used as a waterway as far as Zarizyn, from whence a canal of about fifty-three miles length would afford connection with the River Don, and, finally, the Don would form the waterway as far as the Sea of Azov. The cost is calculated at about £2,800,000. The canal would proceed from the Volga, below Zarizyn, reach the division of the watershed between the two rivers in the Valley of Prodowayo, and having passed this, cut the Valley at Kapowka. The highest point up the canal would be some two hundred feet above the level of the sea. There would have to be twenty-one locks, and vessels of 500 to 600 tons would be able to pass through in seventy hours, and smaller vessels in about twenty-four hours. According to another and later plan, the Don would be utilised as far as the mouth of the River Manitsch, from whence the canal would follow this river, pass the division of the watershed between the two seas, and follow the River Kara to the Caspian Sea. A commencement in this direction has already been made by the cutting through of the Isthmus of Perskop, a distance of about ten miles, by which the Crimea is connected with the continent. The waterway from Odessa to Mariapole has thereby been reduced about one hundred and twenty-five miles, but this will not attain its full importance until a canal connects the Azov Sea with the Caspian.

Correspondence.

PROGRESS OF THE ABATTOIR SYSTEM.

Mr. Sydney Lupton writes:—The method in the madness of the Act of 1489, which Mr. Lester rather derided in his paper (see *ante* p. 432, col. 2), depends upon the fact that Berwick and Carlisle were liable to blockades or even regular sieges by the Scots without any notice or formal declaration of war, and hence a supply of animals had to be kept, and possibly slaughtered, within the walls. Perugia, I think, gives an instance of the slaughter-house just within one of the gates of the old fortification.

Mr. T. H. Brigg writes:—In reference to the system employed at the Chicago stock yards in killing bullocks, I find it stated that "a man went along a plank above their heads, and dropped a very heavy spear into their neck, and they dropped at once." (See *ante*, p. 439, col. 1.) My business, which often called me to the stock yards, enabled me to see the process employed in killing bullocks, sheep, and pigs. I considered the methods employed to be infinitely more humane than I was, from time to time, led to expect. The bullocks used to be shot, but now are all felled by the poleaxe, the latter being found to be the cheapest and most satisfactory plan. As related, the man walks over the cattle, and fells one after the other, there being two in each division. When each two are felled, then the floor upon which they are laid senseless is suddenly released, and the two bodies roll into the shed, where the butchers stand in readiness; for fear lest any should recover consciousness, they receive one or more blows from the poleaxe as they lie, after which they are skilfully skinned about the head, whilst the carcase is suspended by the hind legs. Then they are run away with to other butchers, who skin the body, &c., &c., every man to his own work.

General Notes.

Agricultural Implements Exhibition at Vienna.—The Imperial Society of Agriculture in Vienna has decided to hold an International Exhibition of Agricultural Implements and Machinery in that city from the 4th to 7th May next. There will be ten different departments in the Exhibition, namely:—I. Agriculture Department—Implements and machines for preparing the soil, sowing, harvesting, threshing and seed cleaning; methods of transport, field roads, &c.; power for agriculture machines (motors, &c.), cultivation of fields, preparation of hay and preserving fodder. II. Agricultural Industries — Machines and implements for brewing, refining and manufacturing malt, sugar, vinegar, and starch. III. Forestry—Machines and implements for gathering seeds, preparing the soil, nurseries, woodcutting and transportation in forests. IV. Industries relating to Forestry—Machines and implements for sowing and for paper manufacturing. V. Fruit and Cultivation of the Vine—Utensils for the cultivation of fruit and the preparation of wine,

id filtration. VI. Utensils and Machines fo- attle — Machines for preparing fodder, stable nplements, &c. VII. Dairy Implements and iachines. VIII. Fisheries—Artificial breeding of sh. IX. Veterinary. X. Uses of electricity in griculture and forestry, and the industries relating iereto.

Photographic Exhibition at Imperial nstitute.—The Special Exhibition of Photo- raphy in its Applications to the Arts, Sciences, nd Industries throughout the Empire, at the Imperial Institute, will be open for three months, rom the middle of May until the middle of August. The Exhibition will be arranged under seven divi- sions, as follows:—Division I. The History of Photo- graphy. II. Artistic Photography. III. Photo- graphy as an Industry. IV. Photography in its Applications as an Industry. V. Applications of Photography to the Sciences. VI. Education in its connection with Photography. VII. Miscellaneous Application of Photography. The Council of the Institute are anxious to obtain a complete repre- sentation of the past of photography. Section A of the Historical Section will contain a purely historical collection of early processes and their products, together with the appliances involved in their use; also early or historical specimens of the processes and appliances in present use. Section B will show the birth and gradual evolution of the well-known processes of the present day from the first crude experiments to the finished result. The Council will defray the cost of receiving and returning the exhibits in this division.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock :—

April 3.—"Sand Blast Processes." By John J. Holtzapffel. Sir Henry Doulton will preside.

Papers the dates of which are not fixed :—

"The Use of Aluminium in the Separation of Metals from their Oxides." By Professor William Chandler Roberts-Austen, C.B., F.R.S.

"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. Charleton, A.R.S.M.

"The Use of Electricity for Cooking and Heating." By R. E. Crompton, M.I.E.E.

"Electric Lighting of Ecclesiastical Buildings." By Major-General Charles E. Webber, C.B.

"Improvements in Milling Machinery." By J. Harrison Carter.

"Deviations of the Compass." By Professor A. W. Reinold, F.R.S.

"Means for Mitigating the Fading of Pigments." By Captain W. de W. Abney, C.B., F.R.S.

Indian Section.

Thursday Afternoons, at Half-past Four o'clock :—

April 25.—"The Coming Railways of India, and their Prospects." By J. W. Parry, A.M.Inst.C.E., late Executive Engineer Indian State Railways.

May 23.—"Punjab Irrigation: Ancient and Modern." By Sir James Broadwood Lyall, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

Foreign and Colonial Section.

Tuesday evenings, at Eight o'clock :—

April 2.—"My Recent Voyage in Siberia. By Captain Wiggins.

April 30.—"Madagascar." By Captain S. Pasfield Oliver.

May 21.—"Commercial Education in Belgium." By Professor William Layton. Lord Reay, G.C.S.I., G.C.I.E., will preside.

Applied Art Section.

Tuesday Evenings, at Eight o'clock :—

April 23.—"Art of Casting Bronze in Japan." By William Gowland. Prof. W. C. Roberts-Austen, C.B., F.R.S., will preside.

May 7.—"Recent Improvements in Designing, Colouring, and Manufacture of British Silk." By Thomas Wardle.

May 28.—"The Decoration of St. Paul's." By Prof. W. B. Richmond, A.R.A.

Cantor Lectures.

Monday Evenings, at Eight o'clock :—

Dr. D. Morris, C.M.G., "Commercial Fibres." Three Lectures.

April 1.—Lecture III.—Piassava brush fibres —Bahia—Para—Kitool—Palmyra—West African—Madagascar—Cocoa-nut coir-yarn—Coir-fibre—Coir-rope — Coir-bristle — Curled palm fibre — Spanish moss — Epidermal palm fibres — Raphia — Paper materials—Esparto—Spanish—Algerian—Tunisian—Indian Bhabur grass — Paper mulberry — Siam streblus bark—Adansonia or Baobab bark—Mechanical and chemical wood pulp—Common basts—Russian bast—Cuban bast—Lace-bark bast—New and old fibres—Improvements in fibres—Cultivation —Selection—Mechanical and chemical extraction—Summary.

James Douglas, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures.

April 22, 29, May 6, 13.

Ernest Hart, D.C.L., "Japanese Art Industries." Two Lectures.
May, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 1 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. D. Morris, "Commercial Fibres." (Lecture III.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Palace Hotel, Victoria-street, S.W., 7½ p.m. Mr. D. B. Butler, "Portland Cement: some points in its testing, uses, and abuses."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Dr. Carl Pieper, "The German Patent Laws and their relation to Home and Foreign Inventions."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. G. Cadell, "Forestry."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Paper on "Evolution."

Tuesday, April 2 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Captain Wiggins, "My Recent Voyage in Siberia."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Charles Stewart, "The Internal Framework of Plants and Animals." (Lecture XII.)

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Sanitary Institute, 74A, Margaret-street, W., 3 p.m. Dr. Schofield, "Earth." 8 p.m. Mr. T. Roger Smith, "Sanitary Building Construction."

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 4 p.m. Annual Conference. 1. Opening Address by the President. 2. Mr. Rowland Briant, "Photography and Decoration." 3. Mr. Leon Warnerke, "A Note on the Principle involved in the Use and Action of the Ruled Screen for Half-tone Process." 8 p.m. 1. Dr. H. E. Armstrong, "Considerations Suggestive of Experiments attending Exposure and Development." 2. Rev. F. C. Lambert, "Criticism."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m.

Wednesday, April 3...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. John Holtzapffel, "Sand Blast Processes."

Geological, Burlington-house, W., 8 p.m. 1. Major H. de Haigh "Physical Geography and Geology of Mauritius." 2. Prof. Wladimir Amalitsky, "A Comparison of the Permian Freshwater Lamellibranchiata from Russia with those from the Karoo System of Africa." 3. Mr. W. S. Gresley, "Ice-plough Furrows of a Glacial Period in Leicestershire."

Sanitary Institute, Parkes Museum, Margaret-street, W., 8 p.m. Dr. J. J. Sykes and Mr. W. Nisbet Blair, "Combined Drainage from the point of view of Health, Construction, Administration, and Law."

Camera Club, Charing-cross-road, W.C., 4 p.m. Annual Conference. 1. Dr. Hall-Edwards, "The Correct Rendering of Colour Values by Photography." 2. Mr. H. Dennis Taylor, "Telescopic Star Images in Relation to Vision and Photography." 8 p.m. 1. Captain W. de W. Abney, "Temperature and Exposure—A further Variation from a Photographic Law." 2. Mr. A. Pringle, "A Note on Instantaneous Photo-Micrography."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Naval Architects (at the House of the Society of Arts), 12 noon. Annual Conference. 1. Address by the Chairman, Lord Brassey. 2. Sir William White, "Notes on further Experience with first-class Battle Ships." 3. Admiral P. H. Colomb, "The Elements of Force in a Warship."

Patent Agents, 19, Southampton-buildings, W.C., 7¼ p.m. Mr. G. G. M. Hardingham, "The Working of Austro-Hungarian Patents."

Obstetrical, 20, Hanover-square, W., 8 p.m.

Thursday, April 4...Naval Architects (at the House of the Society of Arts), 12 noon. 1. Mr. J. T. Milton, "Steam Pipes." 2. Mr. George Rickard, "Light Draught River Steamers." 3. Mr. D. W. Taylor, "Solid Stream Forms and the Depth of Water Necessary to Avoid Abnormal Resistance of Ships." 7 o'clock. 1. Prof. R. H. Thurston, "The Method of Initial Condensation and Heat Waste in Steam-Engine Cylinders." 2. Mr. A. F. Yarrow, "Description of an Aluminium Torpedo Boat built for the French Government."

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Mr. H. N. Ridley, "The Cyrtandraceæ of the Malay Peninsula."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. B. Tylor, "Animism as shown in the Religion of the Lower Races." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Historical, 20, Hanover-square, W., 8½ p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, April 5...Naval Architects (at the House of the Society of Arts), 12 noon. 1. Herr Otto Schlick, "Vibrations of higher Order in Steamers, and on Torsional Vibrations." 2. Mr. W. Mallock, "The Vibrations of Ships and Engines." 3. Mr. W. Hōk, "The Transverse Stability of Floating Vessels containing Liquids, with special Reference to Ships carrying Oil in Bulk." 7 p.m. 1. Mr. W. A. Martin, "Induced Draught as a Means for Developing the Power of Marine Boilers."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m.

Sanitary Institute, 74A, Margaret-street, W., 3 p.m. Dr. Schofield, "Water." 8 p.m. Prof. W. H. Corfield, "Sanitary Appliances."

Geologists' Association, University College, W.C., 8 p.m. Mr. W. Gwinnell, "The Rocks and Scenery of Western Norway."

Junior Engineering, Westminster Palace Hotel, S.W., 8 p.m. Mr. Walter G. McMillan, "The Study of Alloys."

Philological, University College, W.C., 8 p.m.

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, April 6...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Waves and Vibrations." (Lecture VI.)

Journal of the Society of Arts.

No. 2,211. Vol. XLIII.

FRIDAY, APRIL 5, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Dr. D. Morris, C.M.G., delivered the third and last lecture of his course on "Commercial Fibres," on Monday evening, 1st inst.

On the motion of the Chairman (Mr. Francis Cobb), a cordial vote of thanks was passed to the lecturer.

The lectures will be printed in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, March 28; the Hon. George Curzon, M.P., in the chair. The paper read was "Chitral and the States of the Hindu Kush," by Captain F. E. Younghusband, C.I.E.

The paper will be published in the next number of the *Journal.*

FOREIGN AND COLONIAL SECTION.

Tuesday evening, April 2; Sir Westby B. Perceval, K.C.M.G., in the chair. The paper read was "My Recent Voyages in Siberia," by Captain Wiggins.

The paper will be published in the number of the *Journal* for April 19th.

APPLIED ART SECTION.

The meeting of the Applied Art Section, on May 7th, when Mr. Thomas Wardle will read his paper on "Recent Improvements in Designing, Colouring, and Manufacture of British Silk," will be held at 4 o'clock in the afternoon, and Her Royal Highness, Princess Mary, Duchess of Teck, will preside.

Proceedings of the Society.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 3, 1895; Sir Henry Doulton, Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Caink, Thomas, Woodland-view, London-road, Worcester.
Christison, George Watt, 28, Court-road, West Norwood, S.E.
Garrard, J. M., 25, Haymarket, S.W.
Gowan, Robert Anthony, National Liberal Club, Whitehall-place, S.W.
Hawkins, Rupert Skelton, Indian Midland Railway Company, District Superintendent's Office, Bina, India.
Hutchinson, Major-General George, C.B., C.S.I., Holmleigh, Mount-park-hill, Ealing, W.
Laurie, Edwin Hampden, 16, Blandford-square, N.W.
Walker, Ernest Mowbray, 161, Clarendon-road, Notting-hill, W.
Wilmer, Horace, South Woodford, Essex.

The following candidates were ballotted for and duly elected members of the Society.

Bones, Arthur Anderson, Broadgate, Coventry.
Elliot, George Francis Scott, M.A., B.Sc., Newton, Dumfries, N.B.
Malcolm, Alfred, 499, Ashton New-road, Clayton, Manchester.
Master, Charles Gilbert, C.S.I., Earlsridge, Woodlands-road, Redhill.
Pennell, Joseph, 14, Buckingham-street, Strand, W.C.
Sandercock, Thomas J. Buckler, Sidcup College, Kent.

The paper read was—

SAND BLAST PROCESSES.

By John J. Holtzapffel, Assoc.M.Inst.C.E.

A paper on the sand blast was read in this room by Mr. William E. Newton, in February, 1875. The invention was then in comparative infancy as regards apparatus and its practical applications in manufactures and the arts. Notwithstanding its continual developments in both particulars, the sand blast is still not popularly known; it is considered that something more may now be said on the subject, and this paper will describe some of the appa-

ratus used and its services, after which it is proposed to show you a few examples of actual practice.

The sand blast was invented by Mr. Benjamin Chew Tilghman in 1870, and, stated shortly, consists of a stream of sand or other abrasive powder, usually dry, but sometimes mixed with water, projected with more or less force and velocity to strike and pulverise the surfaces of glass, stone, metal, and other materials upon which it is directed.

It has been frequently pointed out that, in this invention, Mr. Tilghman has really borrowed or adopted from nature herself, inasmuch as he has intensified and put to use a natural force, of which the effects are always apparent under favouring conditions; that is to say, wherever we find large deposits of loose sand exposed to prevalent winds, by which the sand is caught up and blown against any hard substance, such, for example, as the glass in a window, which soon becomes depolished and obscured by the contact of the sand; or stone, the surface of which, with time, is sensibly roughened and sometimes scored in a manner quite distinct from ordinary weathering.

The abrasives used in the process include ordinary inland silicious sand, sharp builders' sand, powdered glass, emery, from fine to coarse, chilled iron-sand and steel shot; and the streams of these powders are forcibly projected through variously formed nozzles by means of steam, by currents induced by exhaust air, by blasts of air, and latterly, and more conveniently, by compressed air. Sand, from its plenteousness and general suitability, is mostly employed; that used in London comes from Reigate, and, when freed of pebbles and impurities, is again sifted into several sizes for different classes of work.

Grains of sand have numerous angles, and the action of these grains—as also that of the other abrasives mentioned—upon the surfaces of glass, stone, or metal, is due to the circumstance that every individual grain in the incessant infinite number in the stream urged violently forward, has all its energy instantly arrested, transferred, and concentrated upon its point of impact, where it produces a minute pit or depression; and, as every grain in the shower acts alike, the abrasion resulting from the whole is perfectly uniform in depth and texture, or roughness.

The action, moreover, is extremely rapid; as you will see later, a momentary application depolishes glass over any space that can be covered by one stroke of the sand shower, instantly changing the previously bright surface to obscured, or that known as ground glass. A little longer exposure cuts more deeply, and, with further time, apertures are readily pierced through sheet and plate glass.

Stone, marble, slate, and granite are just as amenable to its action. Iron, steel, and other metals have their surfaces easily reduced, and smoothly or coarsely granulated, according to the force and abrasive powder used; but all these materials, being less brittle than glass, take a rather longer time. Speaking generally, it appears that the harder or more dense the material acted upon, and the higher the velocity given to the sand, the more rapid the cutting action; and the finer the abrasion, and the lower the pressure of the air or steam, the finer the granulation produced. It is also remarkable, that it is by no means necessary that the abrasive be harder than the material to which it is applied, thus, hardened steel and corundum are readily pierced with sand.

This granulating, scaling, incising, and piercing, however, is but one-half of the process, for, if the work be partly covered, and protected by some slightly yielding but tough substance, adhesive, or in the form of a metal template lying closely upon it, this interposed substance instantly diffuses the shock of the particles and neutralises their abrasive power. The action of the sand blast is thus confined to the unprotected portions of the surface, and these overlays and templates are used on glass, stone, slate, pottery, and metal for surface ornamentation, for deeper intaglio and perforations.

All results from the sand blast arise from the cumulative action of the immense number of grains of the abrasive powder striking the surface; but the impact of every individual grain does but an infinitesimal portion of the work; hence, as unusual as important, the very rapid erosion is really most gentle in character, with total absence of risk of damage to the material, however fragile, as, for example, the splaying or chipping of edges met with in carving stone by hand.

The sand blast is in constant use for obscuring or producing a uniform granulation, known as ground glass, on sheet glass, lamp globes, the bubbles for incandescent lights and the like; for the decoration of sheet or objects in glass with ornamental designs, in which the pattern or the field may be left bright and transparent, of which there are

numerous varieties, one being on glass of two or more thicknesses of different colours, to leave the design of one colour on a field of another; for the decoration of glass table ware, and the labelling of measures, chemists' and other bottles. Several examples lie on the table.

In metal, for the removal of the hard scale, so destructive to cutting tools, from castings and forgings. The removal of the scale from sheet iron and steel prior to enamelling, galvanising, nickeling, tinning, &c.; the cleaning of tubes and brazed joints, largely used in bicycle work. Sharpening the teeth of files. For granulating or frosting electro-plate, gilding metal, gold and silversmiths' work, and jewellery; and the reduction to clean metal surfaces of larger works, ranging from the steel forgings of safes to armour plates.

On stone, slate, and granite, for incised carving and inscriptions in intaglio or relief; for cleaning off the grime from stone, granite, and brick buildings, and, in contrast to this last, for the most delicate drawing for lithography.

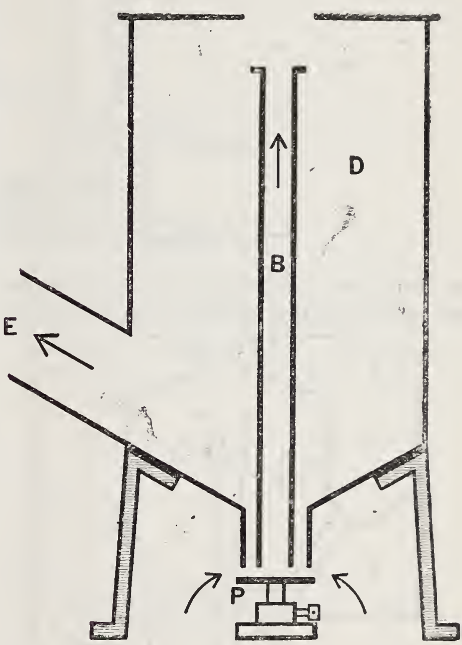
Among other purposes, it is employed for removing fur and deposits in tubes and tanks; for cleaning off accumulations of paint and dirt within iron ships; for roughening the surfaces of metal rollers; for decorating coat and other buttons; for granulating glass to give it a key for ornamental painting by hand; for piercing the apertures in glass ventilators; for marking cakes of cement and glue; for marking pottery, and in the manufacture of ornamental tiles; for smooth facing bricks to receive white glass or enamel; for refacing grindstones, emery, and corundum wheels; for granulating celluloid films for photography; and on wood, to bring out the grain in relief, and, latterly, for blocks for printing.

A list of its users cannot be attempted, but includes the names of Sir W. Armstrong, Charles Cammel, Chatwood, Sir John Brown, Jessop, Sanderson, Turton, Vickers, many English and foreign railway companies, Arculus, Chance, Dixon, Hartley, Hole, Pilkington, and others.

The protecting overlays used in glass decoration are made of a quick-drying, viscid mixture of glue, dextrine, glycerine, and any powdered colouring matter to give body; they readily wash off in warm water after use. Sometimes they are painted on by hand; for many repetitions, they are printed from wood-block patterns on paper, then laid on the glass, and the composition transferred by rubbing, or it is applied through thick tinfoil stencil plates with a palette knife. For figures and original designs, the glass is entirely covered with a sheet of paper dipped in the mixture, through which, when dry, the design is cut out with a pointed knife; sometimes numerous morsels of the prepared paper are separately attached to the glass.

In all stencil plates there are many isolated solid portions, as, for example, the centre of a letter O, which have to be retained in their positions by bars or ties, which cross and interfere with the continuity of the apertures desired around them. For the best works, required in quantities, this is overcome by

FIG 1

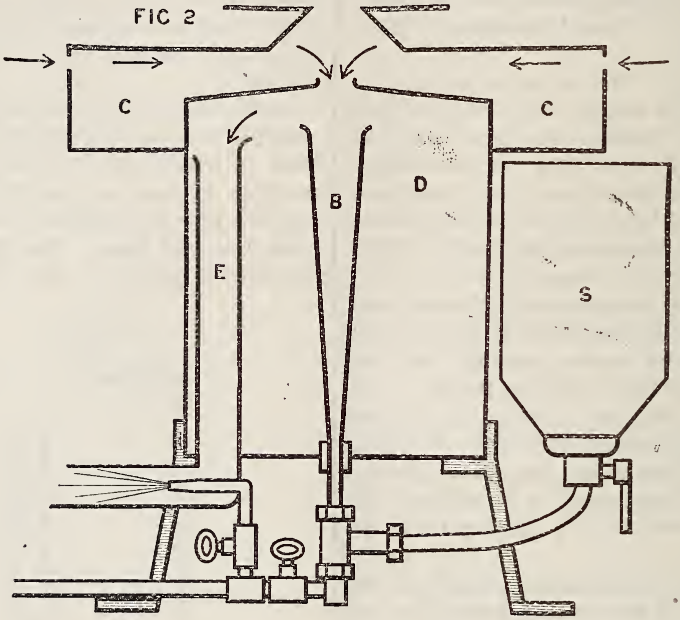


using two or more tinfoil stencil plates, the first giving the design, and the second pierced only with holes corresponding to these ties, to blot them out. On the table there are some such stencil plates, with impressions showing their separate and combined results, and glass with the completed overlay from them.

As to apparatus. An early exhaust air machine (Fig. 1) has a closed iron drum, D, about 30 inches diameter, with an open central pipe, B, and below the latter a vertically adjustable plate, P. The head of the drum has an aperture about 4 inches diameter, closed by the work, overlay downwards, lying upon it, the exhaust being at E. The sand

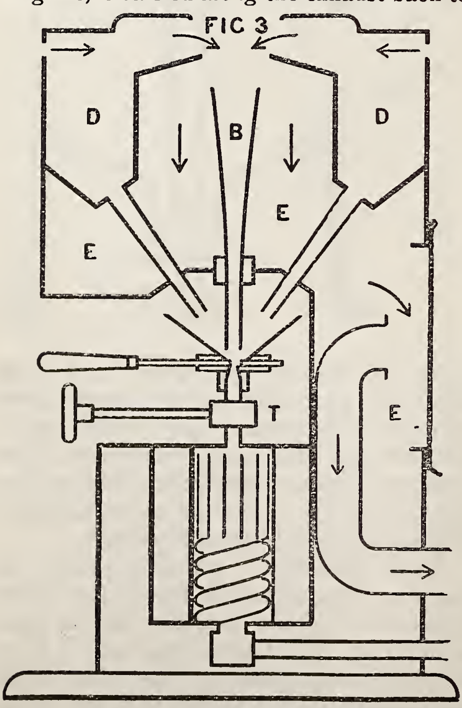
from a closed box falls down the pipe, E, to the bottom of the drum, on to the plate, P, thence impelled or sucked up the blast-pipe, B, by the external air rushing in above the plate, P, it strikes the work, which is moved about by the operator, who looks through the glass to watch the progress of its frosting. Most of the sand falls back to the bottom of

FIG 2



the drum, some, with the dust pulverised from the glass, is carried along the exhaust back to

FIG 3



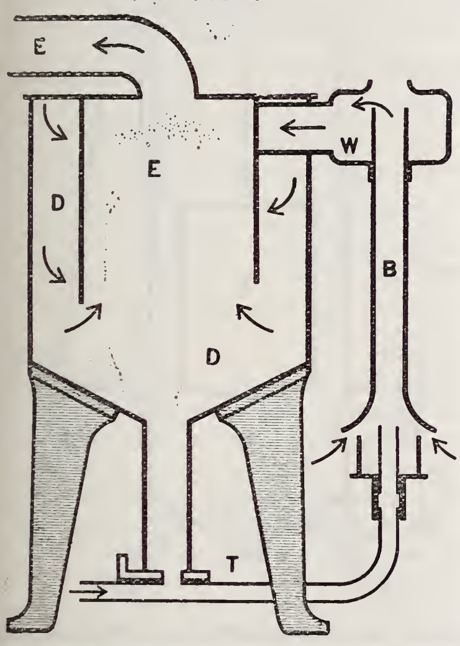
the sand box. The air-pressure does not exceed one pound to the square inch, the frosting is almost instantaneous, and the hand may be held in the blast without inconvenience. Several machines are connected to one exhaust running round the workshop; they are used for small work, but are capable for sheet as large as can be conveniently moved about by two men.

Steam in place of exhaust air has the objection that its moisture damps, and causes the sand to clog about the edges of the overlays. This is partially obviated in one of Mr. Mathewson's earlier machines (Fig. 2). The drum and blast pipe are virtually as before, but D is surmounted by a circular casing, above which the work is laid; the periphery of this casing, C, is pierced with numerous holes, and the drum contains a large exhaust pipe, E, worked by a steam jet from the same pipe that supplies the steam blast. The latter, at about 20 lbs. pressure, carries the sand, falling into it through a pipe from S, up the blast tube, B; and the dry, external air, rushing in all around, C, crosses the sand blast just before that strikes the work, to find its way down the exhaust, E, carrying a great part of the moisture with it.

Drying the steam is nearly perfect in a later machine from the same hand, indicated by Fig. 3; and is effected at two operations,

the first presenting an analogy to the ordinary centrifugal desiccator. The steam passes upwards first through a helical passage, a tubular plate screw, and then, still rapidly whirling, through a plain cylinder, a continuation of the outer wall of the screw, pierced with numerous vertical slits through which the more decided moisture is ejected; all this is at the base of the machine in a box from which the condensed water escapes below. The partially dried steam then rushes upwards by a straight pipe, the contracted end of which is just separated from the lower end of the blast-pipe, B, within a funnel, into which the dry sand drops through tubes from the supply in the drum, D, and is used over and over again. The volumes of steam and sand are regulated

FIC 4



by throttle and plate valves, the handles close together. The head of the drum is pierced around with holes, like the casing in Fig. 2, and, with its large exhaust chamber, E E E, operated by a pipe below, dries the steam a second time as it issues with the sand from the mouth of B. The chamber, E E, is entirely cut off from the annular portion of D, containing the dry sand, and from all the steam arrangements below; practically no sand escapes but falls to the bottom of E, and is removed through a door at the side.

An exhaust air machine (Fig. 4), in like manner, is now preferred to that first described. The drum has a large exhaust chamber, E, open below and worked from above; D also carries the sand which falls through a pipe, regulated by a valve, into the open end of the tube, T, one and a half inch diameter, which, bent upwards, terminates within the open bell mouth of the lower end of the blast-pipe, B, 2 inches diameter, outside the drum. The upper end of B is contained within a box, called the working chamber, provided with an aperture above, upon which the glass is placed. The sand carried up T by the current induced by the exhaust, as it issues is caught by the stronger current of external air entering all around the open bell mouth of B, and, thus accelerated, travels upwards and strikes the work. The exhaust then carries the spent air and sand from the working chamber, W, to the annular space between E and D; here both circulate spirally around, and to the bottom of E, the heavier particles of sand striking the sides of D by centrifugal force, and falling to the bottom, the lighter, and the dust pulverised from the glass, travelling with the air up within E, and away along the exhaust. Virtually free from the escape of sand, the machine almost entirely sifts the dust from the sand, which latter is used again and again.

Large sheets of glazing glass, covered with their overlays, are frosted as to the ground or pattern, whilst gently travelling upon two long, wide, horizontal surfaces or tables placed end to end with a small interval between them; by means of a narrow, uniform stream of fine dry sand, extending the entire length of this interval, impelled upwards by exhaust air at about 1 lb. pressure, to strike the constantly moving glass. This very long, narrow jet issues from between two iron plates, a quarter of an inch distant at their upper edges, or mouth, but more separated and also open below, beneath which the sand, supplied from a long, horizontal, hollow-plate screw of 2-inch pitch, falls from a slit in its case to a trough, and is caught and carried up by the exhaust air. After striking the glass, the sand falls back into a chamber separated from that below but connected with the exhaust, by which latter it is carried through large pipes to a drum or sand chamber above. In this, after passing through four double cylinders, placed radially in the head of the drum—of the same character and for the same sifting of the sand as the one described in Fig. 4—the sand cleansed from the dust falls to the bottom to pass to the screw for re-use. Two spindles carrying a number of small indiarubber-tyred wheels, one

to either side of the interval between the tables, the one driving the other by gearing, hold down and traverse the glass. Machines with tables 5 ft. wide will obscure sheet glass at the rate of about 300 square feet per hour.

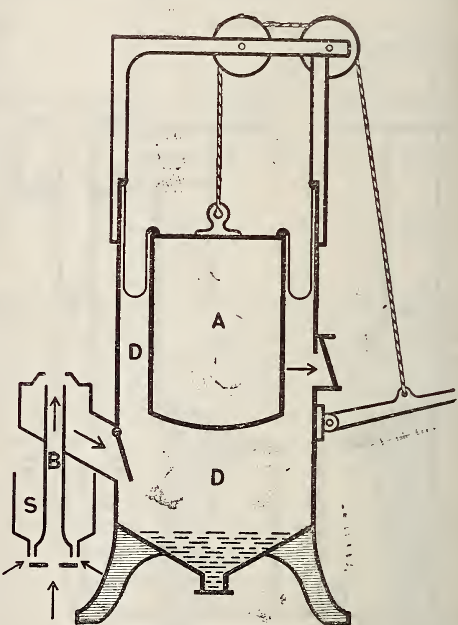
A beautiful translucent variety, known as chip or crystalline glazing glass, covered with grey filaments and fern and feathery markings on an ice-like ground—specimens of which are on the table—is also remarkable for the peculiarities of its manufacture. The surface first uniformly frosted with the sand blast, is then covered with a coat of strong glue, and when this has set, the sheets are placed in horizontal racks in a room heated to 160°. In the course of ten or twelve hours, the hardening glue audibly cracks and springs off in patches, bringing away thin flakes of the glass with it. The fern-like markings are irregular portions of the original sand-blasted surface which remain on these flat conchoidal fractures.

This simple process was discovered by an accident, and put to use by Mr. Corsan. Beyond the curious fact that glue, under such conditions, will tear flakes from glass, the explanation appears to be that the hardening glue gradually blisters, and these blisters as they detach, tear off more of the glass by their margins than towards their central portions, which latter leave the fern-like markings. By the employment of the ordinary overlays prior to frosting and gluing, the crystalline effect is sharply localised and confined to any portion of a design.

Lamp globes and spherical objects are plain or pattern frosted all over their superficies in an ingenious manner. The drum of the machine—about as high as its diameter—has a hinged cover, and moves round on a central vertical pivot. Diametrically within the drum is a spindle, or rather the two ends of a spindle, its central portion removed and replaced by corresponding rods, with spring means of holding, which carry the glass globes. The globe, when in its place is exactly in the centre of the drum, and the tube of the sand blast, presented horizontally, points precisely to the centre of the globe. During the frosting the spindle is continuously turned, and the drum itself moved round on its pivot through about a half circle, both automatically; the central line of the spreading sand shower—its most active part—thus always points to the axis of the globe, which secures absolute uniformity in the texture of the frosting. Dry sand and air, at about 1 lb. pressure, are used for ordinary work, and very fine sand, with steam at about 20 lbs. pressure, for the best class of this work. The globes are replaced with expedition, and from 60 to 100 may be completed in an hour.

Bellows machines for marking labels through stencils on small ware, are worked by manual and hydraulic power. One (Fig. 5) has a heavy, cylindrical plunger, A, within the drum, D, the upper ends of the two connected by vulcanised india-rubber, which peels off from the one to the other as the plunger reciprocates, making an air-tight and practically frictionless joint. Below, the drum has inlet and outlet valves, and, externally to the former, the sand blast. The base of the blast pipe, of 1½ inches bore, is surrounded by a

FIG 5



cup, S, pierced with holes below, and beneath there is a vertically adjustable plate or disc. The sand placed in S falls on the plate, and is carried up by the inrush of air between that and the lower end of the blast pipe to strike the work, it then falls and collects in the base of the drum. The plunger is raised for every impression, the lever worked by an assistant, sometimes by standing his weight upon it; in smaller machines, it is placed close to the blast, and worked by the left hand, and the objects to be frosted changed by the right.

These machines—one of which is before us—are among those used for marking publicans' half-pint glasses, after verification, at the four principal Weights and Measures

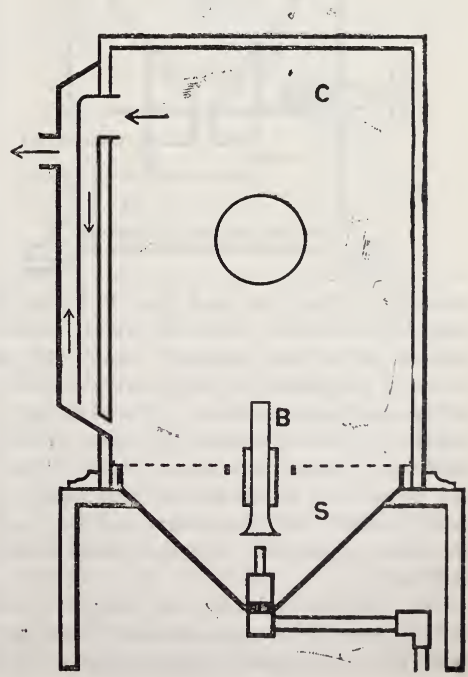
Offices of the London County Council. The marks are given through a steel stencil plate, and, in any one such machine, worked by two men, at the rate of 650 per hour, the cost for wages being 1s. 6d. per 1,000 glasses. From particulars kindly given me by Mr. Alfred Spencer, chief officer of the Public Control Department, London County Council, it appears that, in the year ending December, 1894, 575,942 such glasses were marked at these four offices alone. Inclusive of these, the total number of measures of all kinds submitted for marking in the County of London, during 1894, was 1,032,382; of these, 773,168 were verified and marked, and 259,214 rejected.

London County Council. Public Control Department. Return on Sand Blast Machines in Use at the Four Principal Weights and Measures Offices.

Office.	Machine and Motive-power.	Men employed in working.	Average number of glasses marked per hour.	Average cost per 1,000 glasses. Labour.	Water or Gas.	Total.
				s. d.	s. d.	s. d.
Western, Edgware-road.	Tilghman's. Hand-power. (Mathewson's Patent.)	2	650	1 6	..	1 6
North Central, Rosebery-avenue.	Tilghman's. Hydraulic-power; worked from New River Company's high-pressure main. (Mathewson's Patent.)	1	500	1 0	1 $1\frac{1}{5}$	2 $1\frac{1}{5}$
Eastern, Bethnal-green.	Tilghman's. Hand-power. (Mathewson's Patent.)	2	650	1 6	..	1 6
South Central, Newington.	Tilghman's. Compressed air; worked by $\frac{1}{2}$-horse-power gas-engine. (Mathewson's Patent.)	1	1,200	0 5	0 1	0 6

Granulating designs with overlays and frosting on moderate-sized works in metal, is generally conducted within a closed drum or box glazed on one or more sides to watch progress, and with holes in the sides of the box with elastic sleeves for the hands to hold the work in the vertical sand blast. Fig. 6 shows on an enlarged scale, the upper part of a small apparatus by Messrs. Coldwell and Davis, to be used presently, which brings the practice of this decorative art on glass and metal within the reach of the amateur. The air jet is produced by bellows in the pedestal, worked by a treadle, and passes upwards through a conical basin, S; its nozzle tube of three-sixteenths aperture, and the trumpet-formed base of the five-eighths blast pipe, B, are adjustable one towards the other, and the sand supply in the basin covers about one-half of the length of the blast pipe. A tube and cover outside the case, C, provides the air outlet; most of the spent sand strikes the top of the case and falls back into the basin, that carried away with the air collects and falls back through a slit at the base of the air tube

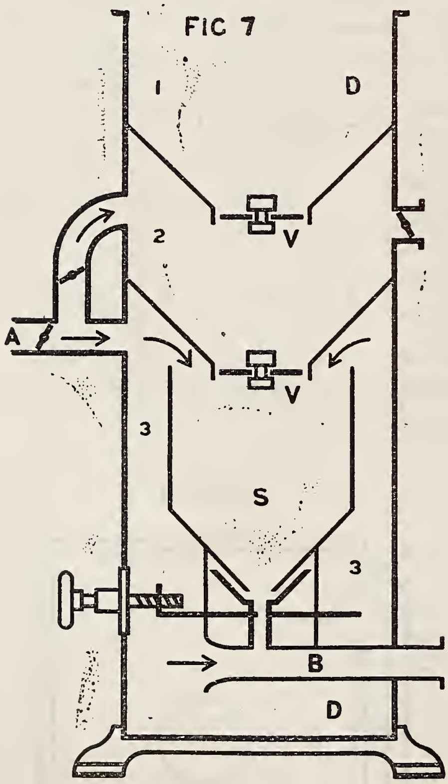
FIG 6



cover, practically none escapes. The pieces of work are arranged on a wire netting over the basin, and, with the casing replaced, are picked up one by one and laid down as completed. Small work is introduced piece by piece in the fingers through one of the sleeve holes.

For large works in metal, from the removal of scale from castings and forgings, and obtaining uniform clean surfaces on plates for galvanising, tinning, &c., up to the heaviest, the production of such surfaces on armour plates—the last previously effected by planing and other expensive methods—it is generally

FIG 7



necessary to take the sand blast to the work instead of the work to the apparatus. Compressed air is then generally employed, a means of propelling the abrasives which bids fair to supersede all others. The plant on a larger scale, but otherwise the same as that before us, is driven by any convenient power, and consists of an air-compressing pump, a store chamber for the compressed air, and the blast apparatus; the last alone needs description.

The external cylinder, D (Fig. 7), is divided into three compartments, two air-tight and the topmost open above. The sand shovelled through a sieve in this last, falls through valves into compartment 2, thence through similar valves into the open-mouthed sandbox, S, fixed in compartment 3, and from this through a funnel-mouthed pipe into the open end of the delivery pipe, B. The compressed air enters A, fills compartment 3, inclusive of the space above the sand in the box, S, and drives the sand as it falls from the latter, along B to the blast pipe, a piece of plain chilled iron or steel tube from $\frac{5}{16}$ to $\frac{7}{8}$ in. bore, which is held in the hand at the further end of a length of flexible tubing attached to the end of B. The sand in S being in equilibrium as regards pressure of air, falls freely by gravity; its volume regulated by a screw sliding valve, the head of which is outside the drum. Compartment 2 is also filled with compressed air from a branch of the pipe, A, but this is allowed to escape to open the valves in I every time fresh sand is added, so that the issue of the sand blast is continuous and uninterrupted.

Mr. Redman, of the Allan and Hill lines, used a compressor giving 60 cubic feet of air per minute, driven by the ship's donkey engine, a 15 cubic feet storage chamber, and builder's sand, issuing at 10 lbs. pressure from the $\frac{7}{16}$ nozzle of a corresponding blast machine, in cleaning the between decks of the iron ss. *Austrian*, 2,882 tons burden, a cattle boat, from many years accumulated coats of hard sea paint, more than an eighth of an inch thick. The example is interesting, because the tough thick paint precisely resembled and resisted the sand blast, just as do the overlays used to neutralise its action on glass and stone; hence, the pace was slow, about 12 or 14 square feet per hour. But the paint was entirely removed down to the clean metal, and, as I was assured by the operatives, far better in angles and around bolt heads than they could possibly have done it in their accustomed manner with hammers, chisels, and scraping.

The sand blast machine was then replaced by a cognate apparatus, patented by Mr. Redman, containing mixed oil paint; the latter atomised therein and blown as spray by the compressed air through a hose and nozzle, after the same manner as the sand. The exchange of sand for paint is perfectly successful, a uniform coat of flatted paint being laid in the ship on a wall space of 60 feet by 5 feet per hour. A similar arrangement of air compressor, driven by 5 horse-power, a chamber for the air, used at 15 to 20 lbs. pressure, a

eceptacle for the air and paint to mix, nozzle, ınd long hose, was used with enormous saving of time and labour in painting the buildings at the World's Columbian Exposition, Chicago.

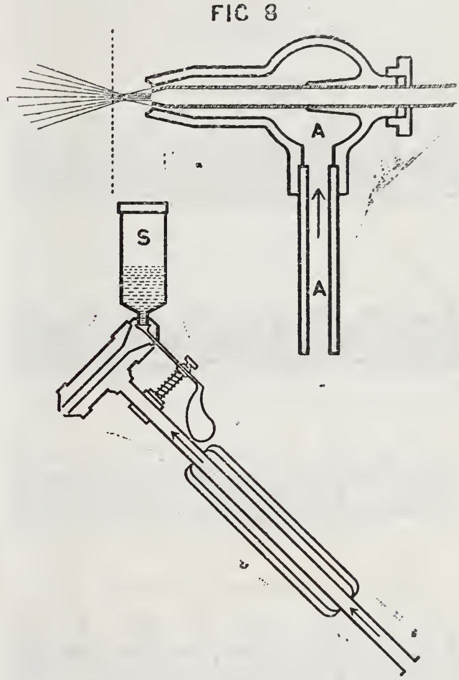
The sand blast used for removing the scale from steel armour plates at Sir John Brown and Company's Works, Sheffield, has the air chamber of 15 feet capacity, and the compressor, driven by 3 or 4 horse-power, making about 180 revolutions, will charge it at the rate of 60 cubic feet of air per minute. The steel blast pipe of $\frac{7}{10}$ bore at the end of the flexible tube, which latter is some 26 feet long, is held at an angle of about 20° to, and at 3 or 4 inches from, the armour plate, and, with chilled iron sand issuing at 10 lbs. pressure, the blast thoroughly cleans off the scale at the rate of one square foot per minute. The operator protects his face from the dust by a veil of fine wire gauze, or, with more comfort, by Mr. Mathewson's air helmet, one of which is on the table.

Tilghman's iron sand, just mentioned, is a remarkable abrasive formed of minute spheroidal pellets of hard chilled iron, produced by letting the molten metal fall through fine holes in fireclay, below which cullender, in an atmosphere deprived of all oxygen, the streams are struck and atomised by jets of superheated steam; the resulting red hot globules drop into water and become chilled to intense hardness. Sifted into sizes, they vary from so minute as forty thousandths up to about one-sixteenth of an inch diameter. This material, of which Messrs. Harrison, of Middlesborough, have lent samples, is also extensively employed to replace sand and emery in sawing stone and granite.

A difficulty has always existed in the wear of the blast pipe, especially when its rear end is separated from the front end of the steam or air pipe, and the sand is picked up from the space between the two; Mr. Tilghman long ago pointed out to me that, if these two pipes be not precisely in one axial line, the wear at once becomes excessive, necessitating frequent renewals. Wear is now nearly and ingeniously prevented in Mr. Mathewson's round and flat blast pipes, which postpone the mingling of the steam or air with the sand until both have issued from the nozzle. The shaded portion of Fig. 8, represents the the pipe through which the sand arrives by gravity or otherwise; this is surrounded by the enlarged hollow head of the pipe, A, the one adjustable lengthwise within the other to determine the extent of the annular space between their open tapering ends; the air or steam rushing up A issues through this space, and converging, catches up and carries the sand forward, the two only mingling at the point shown by the vertical dotted line, well beyond the end of the nozzle.

Sharpening the teeth of files is a notable sand blast process. The teeth of files are formed partly by uniformly distant parallel cuts or indentations, in two series crossing one another, and partly by the burr driven up in making them with sharp chisel-edged tools and in machines. The file pushed forward in the direction of the arrow, wears on the points

FIG 8



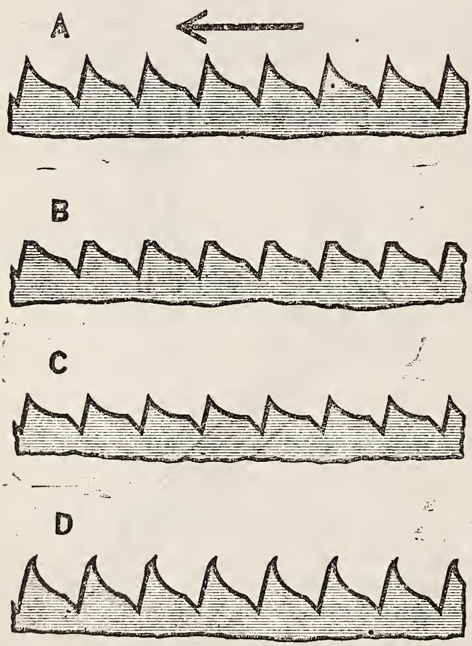
of its teeth, until they become so flattened, as at B, Fig. 9 (p. 482), that it will no longer cut. The only remedy was to soften, grind out the remains of the teeth, re-cut and re-harden; expensive and objectionable in the reduction of the weight and thickness of the blank.

Worn-down files are resharpened in the sand blast by being slowly drawn several times from tang to point between two converging streams of fine sand and water—sand worn so fine in grinding plate glass as to have become valueless for that purpose, and a waste product, is preferred—projected by steam at about 60 lbs. pressure, which pass on from the file into a receptacle for re-use. The effect is rapid, and on both sides of a flat or on all four sides of a

square file simultaneously, a 14-inch rough or bastard file being resharpened in from two to three minutes; second cut and smooth files still more quickly produced by the sand-blasting away of the curved until they again meet the upright sides of the teeth, as at C, and at but little less angle than before. The file throughout the process is drawn across a piece of gun-metal fixed between the sand blasts, and the equal hang of the teeth to this "feeling piece" tells the operator the re-sharpening is uniform from end to end.

Worn-out files so resharpened—tried in the writer's workshops—prove nearly as good as new files on iron and steel, but owing to the

FIC 9



small loss of angle in the teeth, less so on brass and gunmetal, for which the workmen reject them.

Further, and as regards new files, it is found that the teeth do not always prove absolute points, but sometimes curl over, almost imperceptibly, towards the burr sides—shown exaggerated at D. A slight exposure to the sand blast at once removes this undesired hook-shaped burr, leaving the pyramidal points keen. Messrs. Charles Cammel, Turton, Sanderson, and other large file manufacturers, use the sand blast for this purpose.

Opinions long differed as to its value for new files. I have here a new ordinary 16-inch bastard-cut file, one side of which has been sand blasted and the other not—the means of holding this file at any inclination—and a block of gun-metal. I place the unsharpened face uppermost, and the block upon it, and will raise the file until the block slides, which it does at an inclination of about 23°. Leaving the file at this angle, I turn it over with its sand-blasted face uppermost, and replace the block, which now stands still; and I will again raise the file to the angle the increased sharpness of the teeth will retain the block, which appears to be 45°.

A 16-inch bastard-cut file is sand blast-sharpened in 30 seconds; with a little longer exposure, the teeth may be made so keen that the file will retain the block until 70°; but such excess of keenness sacrifices strength, and the teeth become brittle. In practice, the best combination of sharpness and strength appears to be reached when the test-block slips at 42° to 43°.

As a practical test, I am informed that a definite number of strokes, made by a practised hand, with an ordinary new 14-inch bastard file, on gun-metal, will remove a certain weight of metal (say 1·19), but that a similar new file, that has been sand blasted, used by the same individual, under precisely the same conditions, will remove nearly twice as much (or 2·19). There is a less marked, but appreciable difference, on iron and steel, the figures being ·988 to 1·2 on cast-iron, ·352 to ·363 on wrought, and ·674 to ·758 on steel.

Sixty thousand dozens of new files, of all shapes, cuts, and dimensions were sand blast-sharpened for the trade at Tilghman's Sheffield Works during the year 1894. The gross trade list value of these files was £63,680, and the charge for sharpening them was 2½ per cent. on such gross list value. The process being now largely used by many file manufacturers, it is estimated that—inclusive of this quantity—there were no less than 240,000 dozens of new files sand blast, sharpened during the same period in Sheffield alone.

The wet sand, and precisely similar apparatus (except that the two blasts strike the file at right angles instead of at about 20° to its surfaces, so as not to wear away the one sides of the teeth) is now also very generally used for scouring new files, that is, for cleaning their teeth from the salt and yeast adhering after the process of hardening.

Many now also subject files to a short exposure to the sand blast from time to time during use, thus sharpening them like other

tools, to prevent their teeth from ever wearing down to flats. Messrs. Platts, Beyer Peacock, Krupp, the Midland, the London and North-Western, and other English and foreign railway companies, the Royal Small Arms Factory, Enfield, the German, Austrian, Japanese, and other arsenals and dockyards, and numerous other large users, include the apparatus in their plant solely for this purpose.

For stone, marble, slate, and granite, the abrasives are sand, emery, and chilled iron sand, delivered at from 10 to 15 lbs. pressure, usually from the compressed air apparatus already described. The work, which we shall show you presently in operation, is at present confined to intaglio or incision at right angles to the surface, leaving the design on the ground in relief; there are several examples on the table. The overlays are similar to those for glass; if for original designs, they are cut out of thick porous paper saturated with the glue and dextrine, by which also they attach to the plain or polished stone; for work often repeated they are frequently iron stencil plates. The quick yet gentle action of the process annuls all risk of "plucking" or splaying the stone; but in some materials and marbles, and in granite, which may be considered conglomerates, the harder are rather less cut away than the softer constituents; the sparkling granulation then produced is itself decorative, but, if required, it may subsequently be smoothed and polished.

The same apparatus is used for cleaning off the sooty weather deposits from stone, granite, and brick buildings. Mr. Meikle, at Glasgow, employs a portable engine and the air compressor mounted on a truck for conveyance from place to place; an air chamber of 15 cubic feet capacity and a small sand blast apparatus, fixed on a railed stage raised or lowered by tackle, as used by painters; the air chamber connected by lengths of 2-inch vulcanised tubing to the compressor on the pavement below. The abrasive, sharp builders' sand, issues from a half-inch nozzle at from 7 to 10 lbs. pressure. The cleansing is thorough, and, I am told, can be confined to the grime, leaving the plain or carved surface of sandstone similar to that newly worked, and not even roughening the polish on granite. The inclusive cost does not exceed 1s. 6d. per square yard. There is a slab of sandstone before us showing the dirty incrustation, a portion cleansed by the sand blast, and a third portion subsequently treated with a coat of silicate solution, used by Mr. Meikle to prevent future deposits from again eating into the stone.

The antithesis to the work last mentioned, and, certainly, the most interesting sand blast process, that of engraving on lithographic stones for printing, was originated by the late Mr. J. L. Mills, and is now worked by his partner, Mr. Keep, of the firm of Gilbert Whitehead and Company, of London, by whose assistance I shall, in a few minutes, be able to show it you in operation.

In ordinary lithography, the design is drawn on the pure, smooth, polished stone in a greasy chalk or ink, and, although almost inappreciably, really stands just in relief; when printed from, the stone is kept constantly wet with water, which repels the ink—applied with a roller—from all parts of its surface except the greasy lines of the drawing; upon these the water cannot stay, and they alone receive the ink and print.

In sand-blast lithography this is partly reversed. The whole surface of the stone is first impregnated with grease, so that, if then inked it would print a uniform black; and this surface is then eaten away to a trifling depth with the sand blast, to entirely remove the grease from all portions that are not to print, that is, which are to give white; to granulate, or more or less destroy it upon those to give different tones of shading; and to leave it intact upon those that are to print black. All that remains of the original greased surface, therefore, alone prints; the stones being wetted, as usual, prior to inking for every impression.

Sand-blast engraving has been tried for steel-plate printing, and, although still in the experimental stage, it gives good promise of a future. The granulation from the fine emery powder gives the character of a mezzotint, but, unlike an ordinary plate, upon which the rocking is generally uniform, so that it would print a solid block, and is then reduced in tones by scraping and burnishing to produce the drawing, the granulation of the sand blast may be localised and arrested on any portion at any depth of tint; thus reducing the subsequent scraping to a minimum. In printing, the plates are treated just in the ordinary manner; the whole surface is inked, wiped clean of the ink, and finally polished with whiting on the palm of the hand; and then the ink, which remains only in the intaglio of the drawing, is transferred to the paper by the pressure of the rolling press in taking the impression.

A print from a stone, 19 × 13 inches, the

drawing executed by Mrs. M. H. Earnshaw, is a good example of sand blast lithography; it also shows the results of several aids used in the process, which must be briefly explained.

Old stones, long quarried, being more brittle, are preferred for sand-blast lithography. The smooth, polished surface is impregnated with oil and lithographic ink, and then rolled with a thin coat of ordinary brunswick black varnish, the latter used only to produce a brown tone to enable the artist to watch the progress of his work as the lighter tint of the stone shows more and more through the colour; and, lastly, with the stone in a kind of open trough as a rest for the mahl stick, set up on an easel, the general proportions of the drawing are sketched in with chalk, as on canvas with charcoal.

The "sand pencil" generally used is a small copy of the nozzle, Fig. 8, shown on an enlarged scale below it. The stem, a ¼-inch pipe by 9 inches long, in a square wooden handle, carries a short tubular cross-head containing the sand delivery pipe; compressed air, at from 10 to 30 lbs. pressure, enters the lower end of the stem from a slack vulcanised tube, and, for large drawings, the emery or other powder falls from a receptacle above through a similar slack tube into the large upper end of the delivery pipe, and the air, rushing out through the fine annular space at the orifice catches and carries the emery with it. A valve, similar to that of a powder-flask worked by the thumb, regulates the quantity or cuts off the abrasive, that air may be sometimes used alone. For small drawings the overhead sand supply is not used, and the abrasive is then contained, and falls from a cylindrical box, S, fixed to the upper end of the delivery pipe.

There have been several other modifications in details, and lately, an entirely new form. This last, a small cylinder, 4½ inches high by 1½ inches diameter, contains the powder, and is a tiny, simplified copy of the compressed air-machine used for armour plates. It is grasped in the left hand, the compressed air at from 5 to 15 lbs. pressure enters from a flexible tube towards its upper end, and the sand or emery, regulated by a valve worked by the thumb, is ejected from its base through a lesser flexible tube to a pin-hole steel nozzle fixed axially in the end of a rod, the size of a cedar pencil, held in the fingers of the right.

Sand, powdered glass, emery, chilled iron-sand, and steel shot are used, according to the quality of the depressions required; but the sand pencils differ only in the bore of the delivery pipe, from that of the finest pin-hole to a quarter of an inch, and, in those so constructed, in that of a correspondingly increased annular space around the orifice. The pencil is held for the blast to strike the surface at about 45°, and is moved about closer to the stone in drawing lines, further from it for wid[er] and at increased distances, no longer for lines but for more and more dispersed functions, which a sufficient repetition yields every varie[ty] of dark to light tints.

The ordinary acceptation of the word proce[ss] reproduction, does not apply; on the contrar[y] the artist records his original conceptio[n] directly on the stone or plate, and is unfetter[ed] in manipulation. He can pass instantly fro[m] lines to broad shading with the same blas[t]; he can use the abrasive best suited to bold [or] delicate work, and he can allow the full [or] diminished escape of that or of air; moreove[r] by numerous simple expedients he can locali[se] the erosion with which he draws.

For example, if his subject be a head, po[r]tions—say the head, neck, and chin—may b[e] in full light against a dark background. If s[o] he commences by cutting out this outline i[n] foolscap paper, and holding the paper down i[n] position under the fingers of one hand, h[e] plays the sand blast up and down its edge wit[h] the other, in a few minute producing thes[e] portions in light and perfected outline. Suc[h] an outline in bright light, is, however, too har[d] against a dark background, and in all drawin[g] and painting has to be softened or rounded b[y] tenderly working or stippling the colour o[f] each into the other throughout its length. With the paper abandoned, this labour is in[]stantly accomplished by the sand blast, which held fairly closed and passed along the outline operates to either side of it, and just sufficiently reduces the tone at the edge of the back[]ground as to destroy all hardness.

The artist then travels all about the drawing, lingering here and there, going and returning from one feature to another, the sand blast sometimes closer to and sometimes further from the stone until, with marvellous rapidity, the whole head is perfectly *ébauché* in light and shade; the work executed in about a tenth part of the time in which it could have been so far drawn with chalk by hand.

To complete the drawing, numerous large to minute portions must remain of the tones already obtained; more must be reduced to lighter, and some, the high lights, to absolute white; the two former for the shadows, eye-

brows, nostrils and the like, some of which must be strongly defined and others merge into lighter tones yet to be obtained, or again, for the roundings of cheek or neck where the gradations must be still more delicate. To obtain these effects, and onwards to the completion of the drawing, the artist resorts to repeated overlays in alternation with the sand blast. These are made by strokes and blots of ordinary white body colour, freely laid on with a sable brush, and quickly dried whilst making by the current of air with the emery cut off from the sand pencil; these touches are followed by re-applications of the sand blast, and are then all wiped off with a wet sponge to observe progress, and so on in repetition. A single stroke of the pigment, used for delicate gradations, is partially penetrated by a light blow of the abrasive; but the thicker blots built up to impasto by repeated touches, penetrate less and less to their central quasi-impervious portions, and yield the nearly abrupt transitions for eyebrow or shadow; thus the actual touch or feeling of the artist is throughout instantly recorded with supreme fidelity on the stone.

This stopping out is carried further. Actual black, as for the pupil of an eye, or any portion of a tint, is preserved intact by painting the shape with a tougher permanent overlay impervious to the blast. Actual white, by painting impasto all around it, or quicker, by a paper guard cut with a hole to its shape, and directing the sand blast into such apertures. Again, masses of pure white, as also delicate high lights in lace and draperies, are accurately preserved by first painting them on the pure polished surface in a mixture impervious to the grease, before that is used to impregnate the surface.

Lastly, flat even tints on backgrounds are obtained with ease, by simply traversing the sand blast at a uniform pace and distance from the stone along the mahl stick, then lowering that, and re-traversing the stone in parallel paths from top to bottom, repeating this until a sufficiently light tint results. Gradated tones are produced by gradually curtailing the length of these consecutive traverses from the light to the dark side.

The print of a child's head—on the table—is a fair example of the delicacy in treatment obtainable in sand-blast lithography. On the wall are bolder specimens, well-known posters, executed with coarser abrasives, but otherwise with precisely the same means, and in the same studio as the child's head.

The poster showing three life-sized figures, accessories, and ornamental border, should be noticed, not only for its merits, and for showing those of the sand blast in drawing, light and shade, varied textures, and aërial perspective, but as an illustration of the remarkable rapidity of sand blast-lithography. It consists of nine sheets of paper, pasted up together, to give the complete picture, printed from nine separate stones, each measuring 60 by 40 inches. The drawing on these stones, from the first touch to their final completion ready for the press, was executed in rather less than nine days.

To conclude,—this paper has but briefly described the sand blast processes in daily extensive use; to its many other applications—less generally practised—time has not permitted allusion; and, I venture to think, wide as is its present range, there is little doubt the sand blast will find yet further use, both in the arts and manufactures.

The sand blast process was shown in operation on glass, stone, granite, and metal by Mr. Hole, Mr. Mathewson, and Messrs. Coldwall and Davis; and in lithographic drawing by Mr. Keep.

The paper was further illustrated by very numerous specimens of sand blast work and decoration on glass, stone, and metal, contributed by Messrs. Alfred Arculus and Company and Mr. Charles Marlow, Birmingham; Mr. Carson, London; Messrs. Harrison Bros., Middlesborough; Messrs. R. Hodd and Son, London; Mr. Hole, Manchester; the Public Control-office, London County Council; the Sand Blast Engraving Company, Sheffield; the London Sand Blast Company; and others.

DISCUSSION.

The CHAIRMAN said they could not close the meeting, though they were all anxious to see the working of the various processes about to be shown, without passing a hearty vote of thanks to Mr. Holtzapffel for his very interesting and instructive paper. It appeared to him that this was one of the most interesting illustrations they had ever seen of the combination of the useful and the ornamental. There was an infinite and most charming variety of objects, some with the charm of unexpectedness, and others full of artistic value and interest. The last development of this art, its application to lithography, he did not know much of, but it appeared to be capable of extraordinary development. Mr. Holtzapffel had certainly shown that science and art were not antagonistic as was sometimes supposed,

and the processes described appealed alike to the artist and the man of business.

The vote of thanks having been carried unanimously,

Mr. HOLTZAPFFEL, in acknowledging it, said a large share was due to the various gentlemen who had so kindly assisted him, without whose aid the proceedings would have lost the greater part of their interest.

The SECRETARY announced that the various specimens exhibited in the reading-room downstairs would remain on view to members and their friends for the remainder of the week.

Notes on Books.

DRAINAGE WORK AND SANITARY FITTINGS. By W. H. Maxwell. London: The St. Bride's Press. 1895.

This little book is a reprint from the *Surveyor* newspaper. Its obj ct is "to bring together, in a condensed and handy form, chiefly for the use of students, the main points connected with the construction, examination, and testing of drainage works." To this end descriptions and drawings are given of the various classes of drains and sewers, joints, traps, ventilators, &c.; systems and methods of laying drains are described; there is a chapter on testing, and a synopsis of the Local Government Board model bye-laws. The sections of Public Health Acts having special reference to sewerage and drainage form the final chapter of the book.

Obituary.

WILLIAM BOTLY.—Mr. William Botly, a member of many years' standing of the Society, which he joined in 1865, died on the 8th of January last, at the advanced age of 91. Mr. Botly was at one time a very regular attendant at the Society's meetings, and constantly took part in the discusssions, but of late years his age made his visits infrequent. Mr. Botly was also a constant attendant at the meetings of the British Association and of the Royal Agricultural Society, of both of which institutious he was a member. He was a liberal supporter of many charities both in London and his native town, Salisbury. A few years ago he established in the last-named city a small charity for a few aged women.

General Notes.

ATHENS EXHIBITION.—Information has been received from the Foreign-office, through the Science and Art Department, respecting the Industrial Exhibition at Athens. Her Majesty's Consul at the Piræus reports that a permanent Industrial Exhibition has been organised by the Société Biotechnique at Athens, and will be officially opened on the 28th April (16th April o.s.). This Exhibition, although intended only for native products, will be accessible to foreign exhibitors of such articles as may assist in the development of Greek industries. All expenses will have to be paid by the exhibitors, who will, moreover, have to pay a tax of two drachmas for each article worth 100 drachmas. Articles worth more will be charged half a drachma per hundred in addition. The committee of the Exhibition undertakes to sell the exhibits at a commission of 5 per cent. The Exhibition will be open each year from 13th March (1st March, o.s.) to 12th July (30th June, o.s.), and from 27th September (15th September, o.s.) to 27th January (15th January, o.s.).

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 8......Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Mr. Robert Irvine, "The Relations of Colour to Painting, Printing, and Decoration." 2. Mr. Alexander Frazer, "A Graphic Method of Recording Weather Observations."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Paper on "Theosophy."

TUESDAY, APRIL 9...Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. J. Wright Clarke, "Details of Plumbers' Work."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p m.

Civil Engineers, 25, Great George-street, S.W., 8 p m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Mrs. Acworth and Dr. Acworth, "Notes on the Hurter and Driffield System of Speed Testing."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Miss A. W. Buckland, "Four as a Sacred Number." 2. Mr. J. L. Myres, "A Modern Greek Morality." 3. Mr. T. B. Pohath Kehelpannala, "Ceremonies observed by the Kandyans in Paddy Cultivation." 4. Professor Maxime Kovalevsky, "Lex Barbarorum of the Daghestan."

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. The Bishop of Grahamstown, "Some Social Forces at Work in South Africa."

WEDNESDAY, APRIL 10...Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

United Service Institution, Whitehall, S.W., 3 p.m. Mr. Clements Markham, "An Antarctic Expedition from a Naval Point of View."

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No. 2,212. Vol. XLIII.

FRIDAY, APRIL 12, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ALBERT MEDAL.

The Council of the Society attended at Marlborough-house on Tuesday, 9th inst., when His Royal Highness the Prince of Wales, K.G., President of the Society, presented to Sir Joseph Lister, Bart., F.R.S., the Albert Medal "for the discovery and establishment of the antispetic method of treating wounds and injuries, by which not only has the art of surgery been greatly promoted and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

The members of Council present were—Major-General Sir John Donnelly, K.C.B. (Chairman); Sir Frederick Abel, Bart., K.C.B., D.C.L., D.Sc., F.R.S.; Lord Belhaven; Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.; Sir Courtenay Boyle, K.C.B.; Sir Frederick Bramwell, Bart., D.C.L., F.R.S.; George Ledgard Bristow; Sir George Hayter Chubb; Sir Henry Doulton; Professor Clement Le Neve Foster, D.Sc., F.R.S.; Walter H. Harris, C.M.G.; Sir Frederic Leighton, Bart., P.R.A.; Sir Villiers Lister, K.C.M.G.; Sir Westby B. Perceval, K.C.M.G.; William Henry Preece, C.B., F.R.S.; Sir Owen Roberts, M.A., D.C.L., F.S.A.; Prof. William Chandler Roberts-Austen, C.B., F.R.S.; Alexander Siemens; Sir Richard Webster, G.C.M.G., Q.C., M.P.; with Sir Henry Trueman Wood, M.A., Secretary of the Society, and Henry B. Wheatley, Assistant-Secretary.

Proceedings of the Society.

INDIAN SECTION.

Thursday afternoon, March 28; the Hon. George N. Curzon, M.P., in the chair.

The Chairman, in introducing Captain Younghusband, said that his name was now well known to everybody, and had been for about eight years, since he made his great journey across Central Asia to Kashgar, by a new track, and entirely alone, for which he received the gold medal of the Royal Geographical Society, and on no one had it ever been conferred with greater justice. In more recent years he had been employed by the Indian Government in examining and reporting upon those frontier regions which he was subsequently called upon to administer. Those reports were not in the hands of the public, but they contained most remarkable records of courageous and adventurous travel. Having successfully accomplished these journeys, he had, for the past three or four years, been employed as political officer in the region which he might be said to have discovered; and he (the Chairman) had the pleasure of seeing Captain Younghusband in that capacity in Chitral last autumn, and greatly profited by his experience and advice. Affairs in Chitral were at present in a somewhat critical state, and it was a great advantage to have a description of the country from a man who had spent two years there in such a responsible position.

The paper read was—

CHITRAL AND THE STATES OF THE HINDU KUSH.

By Capt. F. E. Younghusband, C.I.E.
Indian Staff Corps.

Attention has been drawn on more than one occasion lately to our northern frontiers of India. We had first the news of Russian armed parties patrolling the Pamirs, and even crossing the Indus watershed into country unmistakably in our Indian protectorate; then we heard of the short and successful little campaign in Hunza; afterwards came the troubles connected with the establishment of a ruler in Chitral, on the death of the old Mehtar, Aman-ul-Mulk, who had governed them for so many years; and now we hear of a Pathan chief invading Chitral, and an expedition being prepared by us to make him retire.

A description of some of the more important little States lying on this frontier will therefore, I hope, prove of value in enabling you to understand what is taking place on the furthest confines of our Empire.

The plains of the Punjab are bounded on the north by a stupendous range of mountains. I have stood on the top of a hill rising in the middle of the plains, and nearly 5,000 feet above them, and from it have looked across the Punjab on to a regular semicircle of mountains. First came the snowy peaks of Kashmir, range behind range of lofty mountains.

Then followed the hills of Swat and Bajaur, and lastly came the snows of Afghanistan, stretching away to the west. On every side, except on that of India, the Punjab is bounded by mountains, and a natural barrier from invasion is formed by them. But while this is the case, it does not follow that we can sit down behind this barrier and not trouble ourselves about what is going on on the other side, any more than the commander of a fort could remain quietly inside it, and not keep a look out after the inevitable chinks in every wall. So, though we feel we are extremely fortunate in possessing on our frontier this wonderful mountain barrier, we recognise that we have to keep our eyes on all the little weaknesses in it; and that is in fact what we are doing, and when we find any insecure point, we do our best to strengthen it.

I do not propose to say anything about Afghanistan, but to describe to you more that part of the northern frontier to which special attention has been called recently, that is, to the States of Hunza and Chitral, and particularly the latter, from which I returned only a few months ago.

These two little States are tributary to the Maharaja of Kashmir, and lie, the one to the north of Kashmir, and the other rather further westward. Hunza, up till a few years ago, had hardly been heard of. It lay deep-hidden in these mountains, and from whichever side it is approached, whether from north, south, east, or west, the traveller has to traverse difficult snow-clad mountains before entering it, while the inhabitants had done nothing to advertise any attractions their country might have, and, on the contrary, resented any intrusion; they were notorious raiders, and the inhabitants of the surrounding countries stood in perfect dread of them. Of this I had ample evidence when I was travelling just outside their country in 1887, and again in 1889-91. On the first occasion I was travelling by a route which the raiders had to cross on their way to the great caravan route which leads across the mountains from Chinese Turkestan to India. I had no other European with me, and no escort, and of the men I had with me three had been captured as slaves in Hunza, and afterwards sold in Turkestan. My men had therefore a good wholesome dread of these raiders, and we could never pitch a tent at night for fear of its ropes being cut down, its being let down like a trap on the top of us, and our being captured inside. We had, indeed, to take every precaution against surprises, and it was well we did so, for just the year after we were there the men of Hunza committed one of their most daring raids: they waylaid a caravan, captured a quantity of goods, and carried seventeen Kirghiz into captivity. In the following year I was sent to inquire into the circumstances of this raid. I visited the spot where it had taken place, persuaded the Kirghiz chief who had been captured—but released on payment of a ransom—to accompany me, and show me the way to the very stronghold from which the raiders had issued, and, with an escort of six sturdy little Goorkhas, we went there, and saw these wild, rough men in their mountain den. The Kirghiz chief and the raiders stood face to face; but even at that time the prestige of Government was so great that they dare not touch him while he was with me; and though their chief afterwards became truculent and hostile to the Government, Colonel Durand's brilliant little campaign taught these people a salutary lesson, and this, and subsequent judicious handling, has enabled us to absolutely stop the raiding, and turn these people into a peaceable and, I believe, contented race.

A campaign, it may be remarked in this connection, does not necessarily mean all the horrors we are prone to connect with war—bad blood engendered, a down-trodden race, and all the horrible concomitants usually conjured up. I think many of our little frontier campaigns might have been avoided by a proper policy beforehand, and especially by being careful to get frontier chiefs in direct personal contact with British officers, and never leaving them alone too long to get so much above themselves that in the end they have to be brought to order. But in a case like Hunza the sharp blow the people received seemed to act on them in the same way as a whipping on a naughty boy. It just brought them round, and made them see that they must behave themselves; and as they were left to be governed by their own rulers exactly as before, I do not think there is any sign of resentment against us. Orientals hate change, and it was no doubt difficult for these rough tribes to accustom themselves to the feeling that they were in contact with a great Power, to whose will they must conform. But it is curious to note how once having been compelled to accept a change, they shrug their shoulders and settle down to the new life as if it was one they had always been accustomed to. In the East always, and especially in States composed of impulsive children of nature, as these are, we must expect the unexpected; but it is

the opinion of every one who has visited the country since the war that the people of Hunza are now contented, peaceful, and happy.

I now turn to Chitral, which is not only the largest, but by far the most important State on this frontier. Here is one of the chinks in the wall of defence. Not a very large one, but certainly capable of being made into a considerable one if we do not look after it, and in time, for not only is there a chink just here, but the wall is thinner, too. Practicable roads across the mountains, especially those by the Baroghil and Dorah passes, lead into Chitral; while the width of the mountains from the plains on the south to the plains on the north, as the crow flies, is 400 miles by the Pamirs and

Gilgit, but through Chitral only 200. So Chitral is a place to be looked after and efficiently guarded.

It is a mountainous country, which, if you could get a bird's-eye view of it, you would see to be composed partly of gigantic snowy peaks, mostly of barren rocky mountains and, in a very small degree, of cultivated land. The valleys are narrow and confined, the main ones in their inhabited portions running from 5,000 to 8,000 feet above sea level. It is only in them that any cultivation at all is found, and even there it is not carried on very extensively. But what there is is generally good, and Chitral is a country noted for its fruit. Every day during the season the Mehtar would send us great baskets of the most delicious peaches, grapes, apricots, pears, or

apples—whichever was in at the time—and nothing could be more delightful than the feast of fruit which would always be provided as you rode into the cool shady villages at the end of a long, hot, dusty march over their execrable roads. Dried apricots, too, form what one might call a staple part of the food of the people. Besides fruit, all the ordinary cereals are grown—wheat, barley, Indian corn, millet, &c.—though in the higher part of the valleys it is only possible to produce barley and buckwheat. But the whole food production is small, and barely suffices for the people of the country, leaving little to spare for outsiders.

The climate varies of course according to the height of the valley. In the lower parts, at about 5,000 feet above sea-level, it ranges from 12° or 15° in winter to 100° in summer, and higher up at 8,000 feet it would vary from 5° or so below zero to about 90° in summer. But some places like Gugis, for instance, one of the fortified ports, where trees are scarce, even at 7,000 feet the heat is very often very great in summer, for the sun comes baking down on these bare rocks, and the rays seem to get focussed down the deep V-shaped valleys, producing an amount of heat very much greater than those accustomed to that in places of the same height—situated on the top of a hill like Simla is and surrounded with trees—would imagine.

The population of Chitral is probably about seventy or eighty thousand. The people are all Mohammedans, but not of a very strict or fanatical type. In the lower part of the Chitral valley, where they touch on Pathans so noted for their fanaticism, they have become to a certain extent tainted by it, but in the upper valleys the people are very quiet, and the mass of them do not, I think, trouble themselves very much about religious observances. During the Ramzan, I asked one of them why he was not saying his prayers. He replied, "How can I? I have no clean clothes." Most of the people are like this man, and have no clothes, and they leave the religious observances to be carried out by the more fortunate ones who have. The priests no doubt have a certain influence, especially in the way of aweing them, by telling them of the frightful consequences of doing this, that, or the other, but they cannot work them up into that frenzy which Afghans get into.

On the whole, I should describe the Chitralis as a peaceable race, who, I believe, can fight well enough, when they are roused to action, but who really prefer to keep quiet, and be left alone to enjoy life in peace. When I first went to their country, I was anything but taken with them. They seemed to me to be rather a gloomy set, who did not much approve of the presence of a stranger among them. But, for one thing, my first visit was made in the depth of winter, which is always a depressing season with these people, for firewood is scarce, snow lies deep everywhere, and the interior of their houses, without any chimney or windows, is anything but a cheerful place in which to while away month after month; and, for another thing, they had just been going through all the trouble connected with the struggle for the throne on the death of the old Mehtar. But the Chitralis appeared in a very different light in the following autumn, when the crops were in, and they had plenty to eat; when the weather was clear, and bright and sunny; when they knew for certain who was and who was not to be their ruler. Then they appeared cheery and hearty; they showed all their love of amusement, of singing and dancing, and their keenness for sport. Every man who can get hold of a gun of any sort, goes off to the river side, and shoots duck, as they pass down on their way to India, or goes stalking flocks of pigeons from field to field, while the noble of the country takes his hawk, and flies it at everything he can see, from doves to hares. There is not a man in Chitral who is not passionately fond of sport. They get wildly excited over it, and the late Mehtar, Nizam-ul-Mulk, was the keenest of any. In the spring and autumn he would hold his durbars in the open by the river side, and whenever a duck flew by, he would stop all affairs of state, jump up, and fly his hawk after it. Polo is another relaxation which these people delight in. Every fortunate possessor of a pony, be he young or old (or be the pony young or old either, for the matter of that) plays away wildly; and in their game there is no troublesome rule about off-side or crossing to fetter them, or any limits to the number of players on either side. They hit the ball where and when they can, gallop about whereever they please, knock each other over, and enjoy themselves thoroughly. A solemn game of polo down in India seemed a very dull affair after a round in Chitral.

I hope, from what I have already said, you will have been forming an idea of the Chitralis as an impressionable, impulsive people, their mood, perhaps, more dependent than most people's on the state of their inner man, and of

the weather, wanting to be happy and enjoy life, if they can, and in the main a decidedly likeable race.

I now wish to say something about their rulers and their system of government. The ruler of Chitral is designated the Mehtar, and his power is most despotic up to a certain point. All the land is supposed to belong to him, and the people as well. He can give away a man's fields, or his house, or his wife, or his daughter, or the man himself, just as he thinks fit. I constantly saw instances of this while I was in Chitral, but the most curious part was when a man's wife had been given away for a year or two, and then the original husband's offence was condoned and his wife restored to him again. I believe, too, that it was when General Lockhart was in the country —nine years ago—that the old Mehtar of that time, when witnessing some practice with a rifle, pointed out a man on the opposite side of the valley, and asked General Lockhart to shoot at him, and when the Englishman objected and said that it was a man he wanted him to shoot at, the Mehtar replied, "Yes, I know it is; but he is my man — he is my property, so why not shoot at him? I don't mind."

But, of course, this absolute despotism has, in practice, very effectual checks. On first hearing of this autocratic power of the Mehtar, one is led to imagine that he can do anything. As a matter of fact, however, he is held within very close bounds in certain directions by custom; and then, again, the amount of power he can exercise depends very largely on the man himself. I think most Orientals, and certainly these tribes of the Hindu Kush, like being governed despotically. They talk with pride of a ruler who can really rule them, and they are never so unhappy as when they have no one to govern them, or only one unable to make his authority really felt and appreciable, and it is for this reason, I think, that a strong man is able to make himself still stronger, and assume the amount of authority which a normal Mehtar of Chitral does. The inclination of the people is towards having a strong man to govern them, and when he shows his strength, instead of opposing him the tendency is to give in to him. But this up to a certain point only. Nearly all the affairs of state in Chitral are carried on in durbar. These durbars are held twice a day—in the forenoon and at about ten o'clock at night—and are attended by all the principal men in Chitral. Dinner is served during the durbar, the Mehtar eating with his people, but out of separate dishes and on a raised seat, and over the dinner the business of the country is transacted. Very little is done in writing in Chitral—there is indeed no written language, and the few letters that are written are in Persian. Practically all the internal affairs of the country are transacted by word of mouth here, man to man in durbar. So the Mehtar is in constant touch with his people and they with him. He knows well the characters of the men about him and they know his. And moreover as matters are discussed very freely amongst these open-spoken people, and spades are usually called spades and not shovels, he can gauge pretty accurately from the conversation he hears going on what the drift of opinion is. This then is the hold the people have over their despotic ruler. A very strong man like old Aman-ul-Mulk can bear down against a good deal of adverse public opinion, but even he was kept in check by it, and the late Mehtar Nizam-ul-Mulk, with whom I had to deal, was very largely guided by public opinion,

You will have seen then that these durbars form a very important function in the system of government of the country, but these are not only useful for purposes of government, they serve also for those of education. It is the custom in Chitral for all the chief men of the country to come in once a year for two or three months to pay their respects to the Mehtar and attend the daily durbars. In a similar way the lower classes have to send in relays of men from each district to serve the Mehtar for a few months every year. So daily in durbar there are two or three hundred men from different parts of the country, and besides these visitors from other countries are expected to join in fairly often to show respect to the Mehtar. If they do not do so they may be pretty sure that their stay in Chitral territory will not be rendered too excessively agreeable. Hence a durbar includes many varieties of men, and, as in Chitral, though one class pay extreme respect to another, for instance, whenever a man of one class enters a room, all those of his own class bow respectfully to him, those in a class below would rise to their feet; yet there is considerable freedom in conversation between the classes. Of course, all do not talk upon precisely the same terms of equality, but still a lower class man gets in his say, and even the Mehtar would chaff and address men in the lowest class of life. One of the pleasantest features, indeed, about life in Chitral is the freedom of intercourse between

the several classes, strictly defined and preserved though they are.

The result of all this is—to come to my original proposition—that the durbar forms an excellent school of education. Man mixes with man, class with class, and the people —though they learn nothing from books, for there is no written language in the country, and I doubt if there are a dozen men in the whole of Chitral who can even read or write Persian, which is the only language in which written communications can be made at all—yet learn a very great deal at first hand from mouth to ear. They hear the history of their country from the elders, to whom it has been handed down by those who have gone before. They hear what is going on in other states from those who have come from them. They hear the affairs of their own country being discussed by all the best men in it; and they discuss those affairs freely themselves. They speak out what they have to say, and by so speaking get to know what they really think. The upper classes are not absolutely shut off and secluded from the lower, and so the latter get to know those above them personally, and to pick up a good deal of the natural superior refinement from them, and the upper classes know those under them, and, on the whole, treat them considerately.

I am not sure that all the advantages which, theoretically, should accrue from this system are, in actual practice, produced by it, but I think it is certain that the constant direct contact of man with man, of class with class, produces an intelligent and practical race of men. They are of course, capable of improvement. I do not pretend to say that they are perfect in any way. But what I wish to bring out is, that because men cannot read or write, it does not follow that they must therefore be boors. In European countries, when the classes are so separate, and where the lowest have so little opportunity of mixing with and hearing the ideas of those above them, it may be so. But when men are accustomed to mix so much together, they learn human nature and human character, and their wits get sharpened. And this is the reason why these men are shrewd and quick in detecting the character of a stranger, as they are noted to be.

We have, then, a people, living in a country of extremes; a country of deep valleys and lofty mountains, of barren hill-sides, and beautifully shaded and cultivated village lands; of hot, bright sun in summer, and hard frost and deep snow under the gloomy shadows of the hills in winter. No wonder that the people also show extremes of character, and that, quiet and peaceful as they seem, and as they usually are, their history is one of sudden, startling events, interspersed with periods of apparently profound repose.

Of their more recent history I propose now to give you a short sketch. Nearly 20 years ago, when Colonel Biddulph, the first European to enter the country, visited Chitral, it was governed by a stout old ruler, named Aman-ul-Mulk, one of those strong, masterful men whom such countries need. Up to this time the country, which we now call Chitral, had been split up into a number of little States, and these he succeeded in absorbing and welding into one large State under his rule, while he kept the fort of Chitral as the seat of his Government. But Aman-ul-Mulk was a man with a large family. I could never ascertain the exact number of his children. I do not think he quite knew himself, but at any rate it was somewhere near seventy, by wives of every shade of respectability. Of these children there were about seventeen sons who could claim a certain amount of respect, and of these seventeen two, who on account of their mother's birth might be considered as the most rightful heirs to the throne—these were Nizam-ul-Mulk and Afzul-ul-Mulk, of whom the former was and eldest.

It had long been recognised that on the death of the old Mehtar, Aman-ul-Mulk, there would be a general scramble for the throne amongst all these sons. Nizam-ul-Mulk, the eldest, was known to be rather weak, and Afzul-ul-Mulk was reported to be ambitious. Among the other sons, too, there were some who were suspected of designs upon the throne when that should become vacant. So it was well known that the death of old Aman-ul-Mulk would be the signal for a general uprising.

This is precisely what occurred. The old man died very suddenly in the autumn of 1892. Afzul-ul-Mulk, who happened to be on the spot at the time while his elder brother Nizam-ul-Mulk was at some distance, seized the throne at once, murdered as many of his brothers as he could lay hands on, then raised an army and marched against Nizam-ul-Mulk. That prince, never noted for courage, made a feeble show of resistance and then fled to Gilgit to take refuge under British rule. The first act in the drama was over, Afzul-ul-Mulk was safely

seated on the throne, and everything settled down as quietly as possible.

But only two months after the death of the old Mehtar there came a bolt from the blue which again upset everything. Afzul-ul-Mulk had disposed of most of his rivals inside his own territory, but there was one outside it who had been overlooked. This was an uncle named Sher Afzul, who was living in Afghan territory close by. He had been an aspirant to the throne in the time of old Aman-ul-Mulk, and was one of the few of his rivals whom that prince had not been able to murder, but whom nevertheless he had driven into exile, where he had remained almost forgotten for many years. It was this prince who suddenly one night appeared before the walls of Chitral. The fort is situated only 47 miles from the Afghan frontier of Badakh-Shan, and Sher Afzul carefully planned that no news of his approach should reach Chitral. He rode rapidly down the valley, accompanied by a hundred or two of horsemen, killed the governor of the district, and surprised the fort of Chitral in the middle of the night. Afzul-ul-Mulk rushed towards the doorway to see what the excitement was, exposed himself in so doing, and was shot dead on the spot. Sher Afzul then entered the fort and proclaimed himself Mehtar. This was the second act. Now comes the third.

You will remember that all this time Nizam-ul-Mulk, the eldest son, had been with us at Gilgit. He was the legitimate heir to the throne, and when he expressed his wish to make a bid for it, Colonel Durand, the British agent at Gilgit, agreed to support him to a certain point with a backing of our own troops. Nizam-ul-Mulk started off. He had one little skirmish with Sher Afzul, and then that prince fled back to Afghan territory, and Nizam-ul-Mulk, the prince with the most legitimate claim to the throne, found himself on it at last, and so closed the third act.

When Nizam-ul-Mulk had entered Chitral, he immediately asked that a British officer might be sent to him, to support him by his presence. Mr. Robertson accordingly was despatched to Chitral. He was a man who, in Kafiristan, Hunza, and Chilas, had done good work, and after he had remained there some months, quieting the people after their recent excitement, and thoroughly examining the situation, I was left there, with an escort of 50 Sikhs, which was subsequently increased to 100; and there, or near by, I remained till October last, when I left for India with Mr. Curzon. Mr. Curzon came right down to Chitral, and I am sure there then was nothing apparent to the eye which would betoken sudden trouble. Mr. Curzon and I treated the Mehtar and his chief men to a dinner, at which there were music and dancing, and every sign of light-hearted enjoyment. The Mehtar was as gay as any of them, and Chitralis are very gay when they are in the mood for it. We played polo together, too; and, to all outward appearance, everthing was as quiet and peaceable as could be.

But all the time there was a cloud overhanging poor Nizam-ul-Mulk. He knew that murder was the custom of the country, and he had often told me that he had always to expect it; but it was hard to realise that it could come so soon. On the first day of the present year, he was shot down while out hawking—of which he was passionately fond—apparently at the instigation of Amir-ul-Mulk, one of the few surviving brothers, who thereupon seized the throne. This was the fourth act.

Lieutenant Gurdon, who had succeeded me, was in Chitral at the time with an escort of a few sepoys. He kept his position in a time of considerable anxiety till more men came up, and subsequently Mr. Robertson, the British Agent at Gilgit, arrived with a force of four hundred men who, according to our latest information, are now in Chitral fort. But meanwhile there are other acts preparing in the piece. To the south of Chitral, and in between it and our own settled territory of the plains of the Punjab, is the country of Bajaur, ruled by a stormy petrel of a chief named Umra Khan. He is one of those daring ambitious spirits who arise in these countries, and whose ruling passion is war and conquest. During the last few years he has conquered a number of the little States around his own, and during my stay in Chitral we had frequent scares that he intended to invade that country also. Once indeed he did attack a Kafir village tributary to the Mehtar, but lost 60 men in killed and wounded in the attempt, and had to retire. Now, however, he thought he saw his opportunity. Nizam-ul-Mulk was murdered, Chitral without any acknowledged ruler, and he accordingly invaded the country, and succeeded in capturing a fort only two marches below Chitral itself. But even this is not all. There is still another complication. Sher Afzul, the pretender, who it will be remembered had made the sudden

raid upon Chitral in 1892, killed Afzul-ul-Mulk, and then had been compelled to retire to Kabul by Nizam-ul-Mulk, now escapes from the custody of the Amir, and as unexpectedly as before again appears in his native country as a claimant to the throne, for which he is now ready to fight in alliance with the Pathan chief, Umra Khan.

This, then, is the country, the people, and their rulers with whom we are now engaged in dealing, and upon how we settle this important but perplexed question will depend the future security of this portion of our Indian frontier.

DISCUSSION.

The CHAIRMAN said Captain Younghusband had given a very fascinating account of a most interesting people and country. He had depicted a society of people frank, careless, impressionable, impulsive, and addicted to dancing, gossip, and sport; and he had described a country consisting for the most part of valleys hidden amongst lofty mountains, at the bottom of which rolled swift and impetuous streams. One of the social and æsthetic characters of the Chitralis he had not mentioned, viz., their great fondness for flowers. He constantly noticed men wearing flowers in their hair, just as a clerk in England carried a pen behind his ear. A further characteristic of the people which might be inferred from the dramatic and tragic records of their recent history, was their astonishing indifference to the sanctity of human life, which was, in fact, much less thought of than animal life in England. No man who committed murder, particularly if it was out of revenge, thought he was doing anything criminal, though, of course, he recognised that he ran the risk of being killed in his turn. During the time they were there, they probably associated with more people upon whom rested the suspicion of crime of one sort or another than they would ever be likely to again, unless they became visiting justices of one of Her Majesty's gaols. It would be one advantage of this campaign that increased British intercourse with these people would lead to a modification of these barbarous notions about human life, and that sounder ideas which they were not unprepared to receive, would make way amongst them. He did not propose to say much on the political aspect of the question as he had expressed his views in a letter to the *Times* that morning, but he should like to say a word in answer to the plea which he had seen urged in some newspapers written evidently by people who did not know anything about what they were saying, that this was an instance of the habit of the Indian Government pushing forward its boundaries in an aggressive and unscrupulous fashion, and manufacturing excuses in order to extend the limits of the Indian Empire. He held that nothing could be further from the truth. Speaking from experience derived not merely from study but from visiting the localities he regarded it as the absolute reverse of the truth The fact was that India was slowly, but of necessity growing up to her true physical boundaries. Nature had planted all round India on the north a stupendous ring of mountain ranges. Up to this range on the north other powers, whose intentions if not hostile could not be considered favourable, were coming; and just as it had been inevitable that they should reach those ranges from the north, so was it absolutely compulsory that we should reach them from the south. It did not matter what Government was in power or what policy was adopted, sooner or later the Indian Government must reach these natural physical limits. A backward policy might retard it, but it would merely add to the expense and involve greater loss of life when the expedition did take place, but would have no more effect on the ultimate issue than on the revolution of the earth. To take an analogy from everyday life, they knew that most people attained their full limit of physical stature somewhere between the ages of twenty and thirty, and you could not prevent a young man from ultimately reaching those limits, but if a boy of thirteen or fourteen suddenly took a leap forward and shot up rapidly you did not accuse him of any violent and unscrupulous act of physical expansion. It was exactly the same with the Indian Government, they proceeded slowly and gradually, but if under some great provocation they made a leap forward the advocates of a retrograde policy then tried to make out that it was a deliberate and unwarrantable act. But it was not so, they were necessary acts, and from his own experience he would say it was with infinite and sometimes excessive reluctance that the Indian Government acted up to the full responsibility of their great position. He might add, by way of criticism, that he thought the Indian Government might do much more than it did for the encouragement of intelligent exploration of its frontiers. He did not mean that they should stimulate irresponsible vagrancy on the part of people whom they could not trust, by which they would only involve themselves in difficulties; but when they had on the frontiers men like Captain Younghusband, who had devoted their lives to the service of the State, who knew and were loved by the people of those countries, and were familiar with the languages and conditions of the people, it would be an act of wise—not of rash—policy to profit by the abilities and enterprise of such officers. In the first place, they would gain a knowledge of the country, and if ever occasion arose to move into it, this would be a great advantage; and, secondly, they would come into contact with the people, and might establish relations which would prevent any necessity for recourse to arms. Unfortunately, in the past, the Indian Government had not encouraged exploration. At the present moment, there was only one Englishman who had travelled any considerable portion of the road between Peshawur and

hitral, the bulk of their knowledge being derived om native travellers and surveyors. He was anxious) travel down by that route himself, but the Indian ;overnment would not hear of it, and, looking back, e was really astonished at the pretexts which were ıvented to arrest or retard his progress. In one place e was told that he could get neither animals nor sup- ılies, whereas, when he got there he found it perfectly asy to procure both. He was told that by going to ;nother place he should offend the Russians, whereas ıe had their written permission in his pocket; and in ı third place he was told he would be in risk of his ife, whereas the track was really as safe as Pall-mall. Lastly, he thought more attention should be paid to he unanimous opinion of frontier officers. He did ıot mean to say that these men did not sometimes regard matters from a somewhat narrow point of view. Everyone looked at matters affecting themselves through tinted spectacles, and it might be necessary sometimes to discount their recommendations. He should be the last to deprecate caution in these matters, but if they had a unanimous opinion expressed by the whole body of men serving on a particular line of frontier, it was not right or wise that such an opinion should be totally ignored by the authorities. His own view was that they should take the best men they could possibly get, place them in positions of responsibility, and then give them a comparatively free hand, and they would not go far wrong. He would say, in the presence of Mrs. Robertson, that the sympathies of everyone would be with her husband and the brave men with him who were sustaining the credit of the British army at this outpost on the Indian frontier. There was every reason to hope that the position was not one of extreme danger, and if ability, courage, and resource could extricate them from a difficult position with credit, Dr. Robertson was the man to do it. He concluded by proposing a vote of thanks to Captain Younghusband for his admirable paper.

General Sir MICHAEL BIDDULPH, K.C.B., said that having been employed as an officer on the frontier for some years, he had gone to some extent over the ground round the foot of the hills. He had dived into the confines of Kashmir, and almost looked into Gilgit, and passed over the Burzil and other passes, and he knew the extreme difficulty there was in reaching Gilgit by a circuitous route through Kashmir. It was stated by Lord Roberts, the other evening, that it was a question of 200 miles direct, and 600 miles round by Kashmir, and that was certainly not over-stated, for it was over 600 miles by the longer route. Having pointed out the positions of some of the routes on the map, he said the country bordering on Afghanistan and Kafiristan was at present very little known. There was no question of the necessity of our keeping Hunza and Nagar; in fact, we only arrived there just in time. The outcome from that was our obligation to occupy the whole series of valleys which terminated in Chitral, which lay on the south slope of the Hindu Kush, there being easy passes leading into Chitral from the north; this fact, independent of the tie between Chitral and the Maharajah of Kashmir, added to the importance of our position in Chitral. It all depended now on what was to be the action of the Government of India in bringing affairs in Chitral to a safe conclusion. The Government were now sending a column from Peshawur into Swat, and he had no doubt, consisting, as it did, of the flower of the Indian army, in a very moderate time, perhaps a month, they would be able to relieve Dr. Robertson from the confinement in which he was now placed. Having known Captain Younghusband in old days, when under his command, he congratulated him on the marked success which had followed his career.

Mr. T. H. THORNTON, C.S.I. (formerly Foreign Secretary to the Government of India), said he was very glad of the opportunity of saying a few words on this occasion, first because he was anxious as an old member of the political service to give his tribute of congratulation to the distinguished member of that service who had read this paper, secondly, because he was the son of one of his oldest friends, and, thirdly, because the paper dealt with a subject in which he (the speaker) had taken the deepest interest for many years. Nearer thirty than twenty years ago, when he had the honour of being secretary to the Punjab Government, a messenger or modest embassy came from the Aman-ul-Mulk, the ruler of Chitral, to the Lieutenant-Governor of the Punjab. The Aman-ul-Mulk had recently consolidated his power, and was anxious to secure the sympathy and assistance of the British Government. The Lieutenant-Governor at that time was Sir Donald McLeod, a man who took the greatest interest in Asiatic races, and in many respects had ideas far beyond his time. He was exceedingly anxious to make a most friendly response to this overture, but in those days the policy of the Government, if such it could be called, was that of rigid abstention from all political action beyond our immediate frontier, and the result was that Sir Donald McLeod's wishes could not be carried out. All that the Punjab Government was allowed to do was to give a small present to the Ambassador, and politely inform the Aman-ul-Mulk that nothing could be done. Since then many changes had taken place, and perhaps one of the most momentous changes was the change of attitude by the Government of India towards the frontier tribes. That change had been brought about partly by the pressure of events, but in no small measure by the influence and example of one man, the late Sir Robert Sandeman. It was his splendid success in dealing with the Beloochis that first taught the Government of India the immense importance of well-directed political influence amongst the border tribes. This led to the application of his policy and methods in other places. They were applied to the Pathan tribes of the Sulimans

of the Kurrum Valley and in the Khyber Pass, to the tribes on the slopes of the Black Mountains, in Hunza and Nagar, and now they found the Government of India was doing in Chitral what it might have done with excellent effect 27 years ago. So the action of the Government could hardly be characterised as "precipitate." He entirely agreed with what Captain Younghusband had said about the importance of the durbar as an instrument of government in native States, and thought that more use might be made of that ancient institution in other places. It was freely urged by the late Sir Robert Sandeman, who held two grand durbars every year, one at Sibi in the cold weather, and the other at Quetta in the hot weather, to which the representatives of the principal tribes in Beloochistan were summoned; and at these gatherings all tribal difficulties were settled, as well as differences between the Khan and his Sirdars, and the result was peace and good order. It was perfectly clear that in Captain Younghusband they had a political officer of the true stamp. To quote the words of Sir Robert Sandeman himself, "To be successful as a political officer on the frontier a man must deal with the hearts and minds of the people, and not only with their fears," and that was precisely what Captain Younghusband had been doing. He was particularly struck by the passage in which he spoke of the importance of personal contact between British officers and the frontier chiefs. It was not by spasmodic demonstrations, or occasional presents of guns or money, or rich dresses, that political influence was obtained, but by the everyday acts of upright and earnest Englishmen. If by these means we were enabled—as he had no doubt we should be enabled in time, in spite of passing difficulties, to do—to change the present 1,200 miles of mountain borders, until lately little better than the home of ruffians and desperadoes, into a fringe of friendly States, we should have the satisfaction of bringing peace to more than a million of our fellow creatures, and of raising up a mighty bulwark for the empire.

Mr. Martin Wood said all those who heard Captain Younghusband in that room some time ago were very glad to welcome him back again after his services in the region he had described, the correctness of his description of which had been corroborated by the Chairman, whose own travels in that sea of mountains were well known. But it might he asked what had this subject to do with the Society, relating as it did to a country in which there were neither arts, manufactures, nor commerce. The reply was that most businesslike societies must have some recreation, and this was one of the occasions on which they had had recreation of a most interesting kind. But it must be remembered that these lofty peaks and ghastly ravines were far beyond the borders of India. There was no doubt that, with our immense military forces, we could reach out our arms to any distance, and could go anywhere we liked, but it was difficult for people [in] England to realise, even with the aid of these phot[o]graphs, what the physical geography of this questi[on] meant. The map showed our boundary near the plai[ns] of Peshawur, and beyond that the most mountaino[us] country on the face of the globe, where all the ch[a]racteristics were entirely foreign to Indian condition[s]. The Chairman had referred to one view of the politic[al] side of the question; but he would remind the aud[i]ence also that the sagacious men who were in contr[ol] of Indian affairs twenty years ago had recorded the[ir] convictions against any extension of our bounds int[o] this barren and god-forsaken country. They predicte[d] that, if once that was done, there would be no lim[it] to it; we should be beset, and India would be ove[r]whelmed by perplexities and financial disorders. Thi[s] had already begun, and we had not yet seen the end.

Dr. Leitner said it would be wrong on such a[n] occasion, when so much had been said of his ol[d] friend, Nizam-ul-Mulk, if he were to be silent wit[h] regard to some of the points raised in this ver[y] admirable paper. He had with him a letter from th[e] late Mehtar, in which he implied that amongst th[e] blessings which he owed to the British Government, was that there was then with him Captain Younghusband, whom he had asked to stay with fifty sepoys at Chitral. When chiefs spoke in that way of British officers, there was no doubt that what Mr. Thornton had said with regard to nativ[e] States was quite correct; and Captain Younghusband ought to be in Chitral now, using his gifts in the direction of the rescue of Dr. Robertson. It must not be taken for granted, however, that all that was stated in the newspapers regarding the desperate condition of affairs was literally true; with the great vagueness with which parties met, dissolved, and came together again in those countries, it was by no means certain that he was in anything like absolute danger. Were it possible for anyone connected with the India Office to enlighten them accurately on the state of affairs, he thought he would be able to console them very much, in spite of the announcement that 15,000, not 14,000 troops, were moving forward. The Chairman had very rightly said in the *Times* that on the intercourse between English officers and the Chiefs very much depended, and he thought that if Mr. Curzon were able to speak with Umra Khan it might do as much good as the expedition. He remembered, when Nizam-ul-Mulk had been alienated by the supposed acknowledgment of Afzul-ul-Mulk, the great parricide and fratricide, and when he considered himself offended by a British political officer snubbing him for offering to send 1,000 men to relieve Colonel Lockhart at Panja, a simple explanation by him (Dr. Leitner) of the habits of Englishmen, when overwhelmed with business, and an assurance as to their innate sincerity and good intentions, was sufficient to make Nizam-ul-Mulk a very warm ally indeed. It was for that reason he thought Mr. Curzon should be supported in protest-

ng against the pernicious and most immoral doctrine of our acknowledging any *de facto* usurper until he was in his turn assassinated by somebody else. With regard to Umra Khan, he had a great many enemies. They were told he had 20,000 men, and had assembled 4,000 mules at Dîr. He should like to know where there was any camping ground for even 100, and whence he was to get 4,000 mules and 20,000 men from. Umra Khan was the son of Aman Khan of Jandôl; his eldest brother, Zaman Khan, succeeded, but would not keep his four brothers with him. His mother asked them to come back, and said it was better to kill one son in order to have peace for all the rest. The remaining sons, thinking their mother's advice good, killed Zaman Khan. Subsequently, Umra Khan shut himself up in a fort with a good rifle which he had annexed from the Peshawur cantonment, and invited his rivals to visit him, and as they came he shot them, and thus cleared his way first to the throne, or rather the supremacy over Bajaur. Close to him was the Khan of Navagai, who had made us offers of service. Umra Khan was a man who believed he had a great mission, and so far, no doubt, Providence had favoured him, but it was possible that Providence might not continue to do so. He had to contend with even Swatis who were very much irritated by his conduct, and altogether, it would be surprising if there were not a perfect hornet's nest around Umra Khan before long, if our frontier politicals were worth their salt. Above all, the Chitralis, who were very different from the Pathans, would not, in the long run, go with him. As to sending 14,000 men by that route, they could not live on the supplies of the country. They must draw their supplies from India. About 1,000 men was as much as was required. The 14,000 men, however, might open up the road. Twenty-six years ago we already possessed a good deal of information regarding the route between Peshawur and Chitral, but were not encouraged to say anything about it, and perhaps it was wise, but times were now changed. He had always been of opinion that the less said the better, and for the last twenty years a map which he had brought with him, four miles to the inch, had been kept quiet, so as not to draw attention to that fairly easy road. It was said it was the most difficult of all the roads that had ever been traversed. It was nothing of the kind; with the exception of about 21 miles over the Lawarai Pass before Askreth it was easy enough. Pairs of bullocks wobbled up the first or Malakand pass, and they did not take the prize for pedestrianism, so that our men would do it easily. They were told that Umra Khan had thoroughly subdued the Kafirs at Askreth. If he had, so much the better, but if he had not they would be rather inclined to help us, and there was no fear on that account. In conclusion, he said he would leave to the Society a detailed account of a route into what had hitherto been considered to be a thoroughly ignored country in order that now, when everything was being divulged with regard to it, even those who, like himself, had been against that policy, might be inclined to give aid with detailed and accurate information. If they could not help drawing attention to these countries, let them now do so thoroughly. Even those who might have considered the policy of non-interference the better could not very well help coming to the aid of those who rightly or wrongly had lifted the veil. Now the veil had been lifted, whatever they did ought to be done thoroughly, so that the great enemy from the north should understand that whether he knew the weak places or not, we were prepared to defend them, first, by kind intercourse with the tribes, a real non-interference, such as Captain Younghusband had pointed out, and then, if need be, by the arms of a united country in which all sank their differences of opinion, and by the vigorous resistance of friendly tribes who would interpose a united front against the advances of an invader, animated by love and sympathy for an England that protected them, but did not interfere in their internal administration.

Captain YOUNGHUSBAND then thanked the audience for the kind attention they had given to his paper, and the various speakers for the kindly references which had been made to him, especially by the Chairman. He could only say how greatly pleased he was that Mr. Curzon should have come up to the State in which he was acting as representative of the British Government. It was not always that a member of Parliament, and one who held such a high position as Under-Secretary of State for India, took the trouble in the hard-earned rest between two Sessions of Parliament to travel to the far frontiers of the Empire, but he thoroughly appreciated his work in doing so, and not only that, he felt quite sure that the people of the country also appreciated it; the Mehtar of Chitral was especially honoured by it, and the good Mr. Curzon did in talking over the situation with the Mehtar was most marked. When he was present the people were able in the Durbar to lay their grievances, not only before him (Captain Younghusband), but also before an independent gentleman, and this privilege they greatly appreciated. It cleared the air and did an immense amount of good.

Miscellaneous.

GERMAN WATERWAYS.

The system of navigable waterways in Germany, especially in the northern part of the empire, is very considerable in extent, and fairly complete. Her Majesty's Secretary of Embassy at Berlin says that from the neighbourhood of Gleiwitz, in Upper Silesia, there is a communication by water through the Klodnitz Canal, down the Oder to the Oder-Spree

Canal, thence to the Spree, through to the Berlin Havel, the Elbe, and so on to Hamburg. From Aussig (in Bohemia) the Elbe affords a navigable waterway, past Dresden and Magdeburg, thence by the Ihle and Planc Canals and the Havel to Berlin, and by the Finow Canal to Stettin and the mouth of the Oder. From Königsberg, in East Prussia, there is uninterrupted water communication through the Hoff (Lagoon) to Danzig, and by the Vistula, the Bromberg Canal, the Netze, Warthe, and the Oder to the Finow Canal, which communicates with the Havel and the Elbe. In the west, the Weser is navigable below Münden and the Ems below Greven, and canal communication exists below the lower Ems, Weser, and Elbe. In the neighbourhood of the Dortmund Colliery district, the rivers Lippe and Ruhr afford a navigable waterway to the Rhine, which river carries vessels up to 1,000 tons burthen. The Moselle and Saar are also navigable, the latter up to the Saarbrücker coal district and the Saar Canal, together with the Marne-Rhine, the Rhine-Rhone, and the Huning Canals, make it possible for coal to be carried thence to Paris, Lyons, and Bâle, without transhipment. With the exception of the Rhine, however, most of the waterways mentioned above could, until recently, only carry small vessels for any considerable distance; but, in so far as the Prussian waterways are concerned—which form 66 per cent. of the whole—constant activity has been displayed by the Government within the last 10 years, both in the navigation of canals and other measures, for the encouragement of inland navigation. There are three principal divisions of German inland waterways, namely, the eastern rivers, comprising the Memel, the Pregel, and the Masurian waterways, the Vistula and the Elbing-Oberland Canal; the central rivers, including the Oder, the Klodnitz Canal, the Bromberg Canal, the Eider Canal, the North Sea and Baltic Ship Canal, and the Elbe; the western rivers, including the Weser, the Ems, the Rhine, and the upper Danube. The length of these waterways is as follows:—Memel, 168 miles; Pregel, 271 miles; Vistula, 433 miles; Oder, 1,362 miles; Eider Canal, 106 miles; Elbe, 1,594 miles; Weser, 597 miles; Ems, 567 miles; Rhine, 1,851 miles; and the Danube, 417 miles; making in all a total of 7,366 miles. The most important new canals which have been built, are being built, or are now proposed, are—(1) the Oder Spree Canal, which is completed; (2) the Ems-Jade Canal, nearly finished; (3) the Dortmund-Ems Canal, begun in 1891; and (4) the Elbe-Trave Canal, the plans of which have been prepared, and the Bill passed. Of all these new waterways, the Dortmund-Ems Canal is considered to be the work of greatest importance, as affording an outlet for the Westphalian, and later, perhaps, also for the Rhenish industrial and coal-producing districts to the North Sea, and by the new ship canal to the Baltic. The scheme includes a large maritime port at Königs-polder, near Emden, and a lateral canal from Oldersum to Emden. The construction of this canal was authorised by the Prussian law of July 9th, 1886 and the work was commenced in the summer of 1891; it is to be finished in 1896. The total cost was estimated at £3,233,000, and of this amount £2,991,000 will be defrayed by the State. The total length of the canal will be 148 miles. The Dortmund-Ems Canal forms the first section of a projected system of waterways, which is intended to connect the Rhine with the Ems, with the lower and middle Weser, and with the Elbe, thus affording, in connection with the existing canals between the Elbe, Oder, and Vistula, a complete line of water communication from east to west through the centre of the kingdom. There have actually been built in Germany, within the last ten years, 60 miles of canals, at a total estimated cost of £630,000 (Oder-Spree); there are present in course of construction 230 miles of canals, at a total estimated cost of £5,701,000 (Ems-Jade, 39 miles; Dortmund-Ems, 148 miles; Elbe Trave, 43 miles). There are also over 300 miles of canals projected (Dortmund-Rhine and Mittelland); but, as the German Parliament has rejected the first of these, the execution of the project is doubtful.

General Notes.

Berlin Industrial Exhibition of 1896.—According to a report recently made by the United States Consul-General at Berlin, that city is to hold an exhibition during the spring and summer of 1896, in honour of the city's advance as an industrial and manufacturing centre. When first mooted, this exhibition was to have had a very broad international character, but other exhibitions—notably the projected World's Fair at Paris for 1900—caused the abandonment of that intention. It is to be mainly an exhibition of the products of Berlin workshops, industries, and fine arts, but will not exclude articles made in Germany, if they are sold in Berlin, or have some other local relationship. The presence in Berlin of an agency or shop for the sale of such articles entitles the German who is not in Berlin to exhibit. Notwithstanding these limitations, there is said to be a way for foreign exhibitors to participate, namely, on the same grounds as Germans not of Berlin, by showing that they have an agency or representative in the city. The exhibition is to be held at Treptow-park, on the upper reaches of the Spree, in the eastern part of the city. The municipality has already granted extensive privileges to several electric surface car lines and one elevated line, in order to place the centre and west of the city in easy commuuication with the grounds. These contain some fine sites on the banks of the Spree in a rather flat country, some distance from the more closely-built part of the town. Great preparations have been made in the way of new bridges over canals and branches of the Spree

Journal of the Society of Arts.

No. 2,213. Vol. XLIII.

FRIDAY, APRIL 19, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRACTICAL EXAMINATION IN MUSIC.

The Practical Examinations in Vocal and Instrumental Music will be conducted by Mr. John Farmer, Balliol College, Oxford, and Director of the Harrow Music School, and Mr. Ernest Walker, M.A., Mus. Bac., at the House of the Society, and will commence on Monday, the 17th June.

Particulars can be obtained on application to the Secretary.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tuesday evening, April 2; Sir Westby B. Perceval, K.C.M.G., in the chair.

The paper read was—

MY RECENT VOYAGES IN SIBERIA.

By Capt. Wiggins.

It is now six years, viz., in 1889, since I last had the honour of making a report concerning my voyages to the Kara Sea to the members of the Society of Arts, at which time the question of this route was still in a very indefinite state. I had then only just completed my several voyages in my Polar vessels, commencing with the *Diana* (1874), *Whim, Thames* (1875-76), and *Labrador* (1888-89). Thus the route through the Kara Sea, though already opened, had been so little investigated that neither Russian nor English capitalists and merchants could consider it as firmly established, *i.e.*, sufficiently safe, though it were but for a few months in the year. Notwithstanding this fact several of the most eminent merchants here in England and in Siberia, such as Fedorov, Trapeznikov, and Sibiriakov, came to the conclusion that in all probability I was right in my assertion that the Kara Sea was open for the navigation of vessels, specially adapted for this work, and that, if the gulfs and estuaries of such large rivers as the Obi and Yenisei were approachable by the sea-route, even if only for a few (two or three) months in the year, it followed as a natural consequence that the establishment of this route would call into life extensive trading relations between Europe and the whole of Asiatic Russia.

In order to make thoroughly clear to you the deep meaning of my phrase "from the *whole* of Asiatic Russia"—it is sufficient to glance at the map. My hearers will please direct their attention to the enormous expanse of territory bounded on the west by the Urals, on the south by the Altai and other mountain ranges, running in an easterly direction on the west, by the Pacific, and lastly, on the north, by the Polar and Kara Seas; occupying a total area of about 4,060,000 English square miles and intersected in all directions by the largest rivers in the world, as regards volume of water, &c., and abounding in animal, forestal, cereal, and mineral wealth, including the precious metals. These enormous waterways flowing from south to north, to a distance of 3,500 English miles, and taking their rise in semi-tropical countries—afford the traveller and the merchant a river communication stretching even beyond the frontiers of China, and consequently this question resolves itself into what extent the Kara Sea route may, or may not, contribute towards the development of trade with these immense regions.

With the object of making clear to you this highly important problem, I must direct your attention to the various outward and homeward voyages that have been made to these regions by me and several other navigators during the last twenty years, trusting that I shall thereby succeed in convincing my hearers of the entire practicability of this sea route. In order to do this I will only describe modern voyages; as time will not permit me to enlarge upon the interesting trading ventures and expeditions in this same sea, undertaken in former times by the Russians themselves—the first pioneers of this route — who, even before the days of Chancellor, carried on a trade with Siberia and China, coasting along the shores as far as the Yalmal peninsula and afterwards

crossing it in their sea-going boats by means of the system of small rivers and lakes, flowing through it in connection with the Obi.

Having long ago been convinced—prior to my first voyage—that the Kara Sea is accessible to steamships of a special construction, I undertook my first northern cruise in the yacht *Diana*, specially adapted for this work, and manned by a picked crew of the best Scotch whalers, who are accustomed to the navigation of the Polar seas.

We set sail from England on the 5th June, 1874, and entered the Kara Sea through the "Iron Gates" very early in the year, *i.e.*, on the 24th June, and naturally met with large quantities of ice, which convinced us that we had arrived in the locality of our intended investigations at least six weeks earlier than was necessary. Notwithstanding this circumstance, we managed to make good use of the time lost by our enforced stay in open water behind the ice in the southern portion of the Kara Sea, in the neighbourhood of the Samoyed and Yalmal coasts, until the ice moved further northward into the Polar Sea, from whence it never returns again.

This movement of the ice northwards is caused by the conjoint action of that warm current, the Gulf Stream, and the waters of the White Sea, the Pechora, and other rivers flowing into the Kara Sea through three straits, the Matochkin Shar, the Iron Gates, and the Yugorsk Shar. The presence of this warm water of the Gulf Stream was shown by thermometrical observations made on the surface, and also its deeper depths in the vicinity of the Kara Gate, where the temperature was as much as 45° Fahr. I also succeeded in making observations of the magnetic deviation of the compass during the whole of my voyage through the Kara Sea—past the limits of Dickson's Island to the north-east—observations which showed a very marked deviation, attaining in the northern portions of that sea more than 30° to the east.

These observations, showing the deviation of the magnetic needle, were made on the ice, at a considerable distance from the vessel, entirely outside of any influence it might have had on the compass. We also became convinced of another very important fact, viz., of the accuracy of the charts of all these places, embracing the island of Vaigah, the mainland of the Samoyed shore, the peninsula of Yalmal, the island of Biely, and Cape Matesal, which does great credit to those Russian travellers or hydrographers who accomplished this task even in those far distant days. The only rectification which is worth alluding to consists in the fact that the actual position of Dickson's Island and the cape of that name is more to the north than it is placed in the old Russian charts.

We also had sufficient time to make a whole series of soundings and measurements, which are useful for navigators, who have now the advantage of availing themselves of corrected charts.

During the whole course of this voyage—as far up as 200 miles inside the Gulf of Obi—I did not find the depth less than six fathoms. I sailed from that place in a northerly direction, directing my course across the entrance of the Gulf of the Yenisei, towards Dickson's Island, everywhere finding the sea free of ice. This was about the commencement of August. Being convinced that the Kara Sea was accessible for navigation, even further north than the mouth of the Yenisei, I returned to England by way of the Iron Gates, having spent two months in the Kara Sea.

In order not to trespass too much on your time, I will now, in a superficial way, make a few remarks concerning the various expeditions—24 in number—commencing from 1874, in which not less than 37 different vessels have taken part, accomplishing voyages to the mouths of the Obi and the Yenisei, and also up these rivers.

Whilst enumerating my various voyages, I also ought to mention that after my first three trips in the *Diana*, the *Whim*, and the *Thames*, in which vessels I sailed from England about the end of June, arriving at the entrance of the Kara Sea two or three weeks later, and finding the same not quite free of ice, I, in all my later voyages, made my calculations so as not to enter the Kara Sea until about the commencement of August, which allowed time for the ice to pass away to the northward.

Voyages made under my Command.

1874. With an exploratory and scientific object, in my hired steam yacht *Diana* (draught 12 feet). As related above, to the Kara Sea, as far as Dickson's island.

1875. In my Polar yacht *Whim* (draught 8 feet). In the Kara Sea, which I found free of ice.

1876. In my Polar steam yacht *Thames* (draught 12 feet). To the Gulf of the Obi and 1,000 miles up the Yenisei; wintered off Turukhchansk. The first cargo of merchan-

dise ever delivered at Yeniseisk, direct from Europe. Sold my vessel to the mayor of Yeniseisk.

1878. In the commercial steamer *Warkworth*. To Nadum on the Obi, near Obdorsk. Delivered 500 tons of general cargo, and loaded the same quantity of wheat for delivery in London. During the whole of this voyage, lasting two months, the Kara Sea was quite free of ice. I steamed a straight course, both outwards and homewards, across the Kara Sea.

1887. In the commercial steamer *Phœnix* (draught 12 feet). Direct to Yeniseisk, where 400 tons of general merchandise were delivered, This was the first commercial steamer with a cargo that ever arrived at that town direct from Europe. The Kara Sea, as in the previous instance, was entirely free of ice. The steamer remained on the Yenisei for river work.

1888. In the commercial arctic steamer *Labrador* (draught 18 feet). Convoyed a river paddle boat, which, in consequence of stormy weather, returned to Vardo (in Norway), and did not reach the Kara Sea. This delay prevented obtaining a cargo at Yeniseisk. I nevertheless steamed into the Kara Sea as far as the Yalmal peninsula, finding the Kara Sea quite free of ice. I returned to England in the *Labrador*.

1889. In the same steamer. To Golchikha on the Yenisei. The river steamers, not arriving at Golchikha from Yeniseisk, again prevented me delivering there my cargo and forwarding up river; in consequence I discharged part of the cargo at Golchikha, and returned to London. The Kara Sea was free of ice. The cargo left at Golchikha was delivered at Yeniseisk in the following year by a river steamer.

1890. In the commercial steamers *Biscaya* and *Thula*, and tug boat *Bard*.* To Karaool affluent, about 200 miles north of Golchikha, near Tolstoi Cape on the Yenisei. The whole cargo, amounting to 800 tons, was delivered at Yeneseisk in the steamer *Phœnix* and barges. The *Biscaya* and *Thula* returned safely to England, whilst the *Bard* remained at Yeniseisk.

1893. Commercial steamer *Orestes*, river boat *Minusinsk*, and Polar yacht *Blencathra*. Delivered at Golchikha 2,000 tons of cargo—steel rails for the Siberian Railway, and other goods. All this cargo has been delivered at Yeniseisk and Krasnoyarsk, some 2,800 miles up river.

1893. Three Russian ships under the imperial naval flag: twin propeller tug *Lieutenant Ovstyn*, river paddle boat *Lieutenant Malygin*, and iron schooner barge *Skuratov*, towed by the *Ovtsyn*. From England, under the command of Russian naval officers, and with Russian sailors; commander-in-chief, Captain Dobrotvorsky, of the imperial navy. This expedition was convoyed by us in our Polar yacht *Blencathra*. All arrived safely at Yeniseisk; these were the first vessels under the Russian naval flag that ever arrived on the Yenisei.

1894. Our commercial convoy steamship *Stjernen*, convoying the Siberian Railway river paddle boats *Pervoy* and *Vtoroy*. From Newcastle to Lukevoi Protok (about 300 miles above Golchikha). The paddle steamers *Pervoy* and *Vtoroy* arrived safely at Lukovoy Protok, and were handed over by me to the representatives of the Siberian Railway. The steamer *Stjernen* stranded on her return voyage to London.

In the course of twenty years I have thus accomplished ten voyages, taking out twenty vessels, during which period not a single vessel under my command was stopped by the ice. This concludes my work, in this direction, up to 1894.

I will now touch upon those circumstances accompanying the stranding of the steamer *Stjernen*.

This shipwreck took place owing to fogs, which continued for five days, all the time during our passage from Dickson's Island into Yugor or Pett's Straits. In consequence of this I had no other means of determining my whereabouts, excepting by the lead and dead reckoning, by which I groped my way, and whilst searching for an entrance to the Yugor Straits, I unfortunately came to the deepest part of the Kara Sea. Here the lead did not touch the bottom with sixty fathoms of line out, even close to the shore, as afterwards was proved. I, therefore, concluded that we were thirty to forty miles further east than was really the case, this error being due to the existence of unknown sea currents, which had carried us to the west. This deep water locality is extremely dangerous, owing to no warning being obtained by the lead.

Had I happened to be where I supposed myself to be according to my reckoning,

* Though I did not personally command these steamers, I nevertheless claim them as connected with my English expedition, seeing that they were dispatched by our Anglo-Siberian Company, and commanded by my brother and my late mates in the *Labrador* steamer.

more to the eastward, with good soundings off the shore, the nearest land ought to have been twenty to thirty miles distant.

In the meantime, about an hour after we had sounded by means of the lead—which did not touch the bottom at sixty fathoms—and whilst comparatively hove to, we unexpectedly struck on a rocky and sandy reef, which here stretches out in a parallel direction to the shore a distance of about three-quarters of a mile.

Notwithstanding every possible effort being immediately taken, such as putting the engines full speed astern, laying out a stream anchor and hawsers, all our efforts proved ineffectual, and to add to our difficulties, the wind and the heavy sea from the north-east, rapidly increasing, drove the vessel harder and faster on to the reef, until all that remained for us to do, was to think about saving the crew, and the necessary provisions, clothing, and portions of the sails, &c., for tents, by means of which we might be able to live for the time being in this bleak and barren coast sparsely populated by the Samoyeds. Fortunately, we managed to effect all this without loss of life, although with very great risk and labour. We erected tents for shelter, and on the fourth day, the fog clearing away, it became evident, that we were about six miles distant from the entrance of the Yugor Straits. The current, that had carried our vessel on to the rocks, turned out to be of considerable strength and set out from the Kara Sea, taking a south-westerly course; whereas, in the Yugor Straits, there is usually to be observed an opposite current flowing into this sea. The causes that produced this southerly current, we may assume, are the north-easterly winds, which continued to blow during the months of September and October.

It is thus evident that the stranding of the s.s. *Stjernen* has nothing in common with those dangers which are caused by ice in Polar voyages; this shipwreck must therefore be placed in the category of ordinary sea accidents, which might happen to vessels in every sea. Ice, in fact, was nowhere near at the time of our stranding.

Whilst dwelling on this accident, I cannot abstain from expressing my deepest gratitude for the speedy help which was rendered us by the Russian Government, in fitting out for our discovery two search expeditions, at a very great expense: one from Norway, and the other from Yeniseisk, under the command of Captain Zaliffsky and Lieutenant Baron Miadal, manned by our English crew from our steamer *Minusinsk*, and accompanied by young Mr. Lloyd Verney, our late passenger, who kindly and bravely volunteered to aid in the search, and also for the pecuniary help shown us, to the amount of R. 5,000, which was sent to Archangel and Pechora by the Governor of Archangel for our travelling expenses.

I cannot also but remember with feelings of the most heartfelt thankfulness the exceeding kind treatment of us all by the representatives of the local administration during our journey from Pechora to Archangel, where the Vice-Governor, Mr. Izvekov, and Admiral Vasiliev, Captain of the Port, vied with one another in their efforts to obtain for me and my crew (49 in number) every possible comfort, our crew being fed and housed at the Russian Government's expense. I will also take this opportunity of expressing my deepfelt gratitude to the head doctor and sisters of the Red Cross of the Archangel Hospital, for their unremitting care to my sick men, suffering from frost-bitten feet, lung complaints, &c. It is also my duty to extend these sentiments to the generous merchant Ivan Alexandrovich Koshevin, who, guided by divine Providence, with rare self-sacrifice, actually saved our lives, by conducting us across the Tundras to the Pechora river from the place of our shipwreck (about 800 versts), with the aid of the Samoyeds and their reindeer, he having great influence over the native tribes. The whole of my crew have now arrived home in good health. I have great pleasure in stating that our Government, through the medium of the Board of Trade, have decided to make substantial rewards to all officials, Russian merchants, and natives who have rendered us assistance.

I must now pass on to other voyages than my own.

Nordenskjöld's Expeditions.

1875. Norwegian sailing merchant vessel *Proven*. From Norway to entrance of River Yenisei. The professor ascended the Yenisei to Yeniseisk on the *Nikolai*, a river paddle steamer, belonging to Kitmanov, *Proven* returning to Norway.

1875. Freight steamer *Imer*. From Sweden to the village of Koriapovskaya, near Golchikha on the Yenisei. Not being able to ascend the Yenisei, the steamer left there a small cargo, and started home. This cargo was taken up to Yeniseisk the next year (1877) by Kitmanov's steamer the *Nikolai*.

In the same year Mr. Gardner sailed from London in his Polar yacht, the *Glowworm*, through the Kara Sea, by way of the Matochkin Straits, to White Island, and returned through the "Iron Gates." This expedition had an exclusively sporting character.

Sidorov's Expedition.

1877. Sailing sloop, *Ibis*, built in Siberia for myself and companion, Mr. Seebohm. Afterwards called by Sidorov the *Northern Light*. This vessel was built for us by Mr. Boiling, an Englishman living in Yeniseisk, and then sold to Mr. Sidorov. Under the command of the Russian skipper, Schwanenberg, with a crew of four Russian sailors, it arrived safely in St. Petersburg. This was the first vessel ever built in Siberia which crossed the Kara Sea and arrived in Europe.

Sibiriakov's Expedition.

1878. Iron freight steamer *Frazer*, and sailing brig *Express*. From Germany to Karaool on the Yenisei. There landed its cargo of various goods. The steamer *Frazer* remained on the Yenisei, while the sailing brig *Express* returned to Germany, thus making an independent passage from the estuary of the Yenisei through the Kara Sea to Europe, with a full cargo of wheat (about 400 tons), under sail alone.

1879. Freight steamer *Moscow*, and sailing brig *Express*. From Germany across the Kara Sea, ascended the Yenisei to Karaool, and there landed goods. The sailing brig *Express* again independently returned under sail alone to Germany with a full cargo of wheat, while the steamer remained on the Yenisei. We again see a sailing brig returning by the Kara Sea without extraneous assistance.

1883. Freight steamer *Oskar Dixon* traversed the Kara Sea without coming across ice, but, by a mistake of the captain, who mistook a deep gulf near the Matisal peninsula for the entrance to the Yenisei, ran on a shoal, and there stuck fast. Sibiriakov and the crew were taken by the Samoyeds to Obdorsk, on the Obb river.

Baron Knoop's Expedition under the Command of Captain Dalman.

1881. Paddle steamer *Dalman*, subsequently named the *Count Ignatiev*, and three barges. From Germany across the Kara Sea, without meeting with ice, reached Yeniseisk in safety.

Trapeznikov's Expedition from the Obi.

1879. Two large sailing schooners, each of 300 tons. Both vessels were built in Tiumen. One of them stranded in the river near Obdorsk, the other safely reached London by way of the Kara Sea, under sail alone, without meeting any obstacle from ice. The first Siberian merchant vessel arriving with cargo in Europe.

German Expeditions to Nadim.

1877. Freight steamer *Luisa* sailed direct to Tobolsk, and remained there. The first sea-going steamer which ascended the Obi.

1878. Freight steamer *Neptune* safely reached Nadim with cargo, and having there taken a new cargo, returned to Hamburg.

1879. Accomplished a similar voyage.

1890. Again a similar voyage. In all three voyages there was no obstacle met with from ice.

Having thus made a cursory review of the voyages to the shores of Siberia for the last twenty years, we see that not less than 24 expeditions, composed in all of 37 vessels (of which 5 are sailing vessels perfectly unsuited to such voyages), safely traversed the Kara Sea without any misadventures or hindrances from ice. All the vessels were interested in these voyages from a trade point of view. It is here to the point, and I consider it my duty to say that the two last expeditions, under my leadership, owed their realisation solely to the magnanimous enterprise of the well-known English sportsman, Mr. Leyburn Popham, the owner of the Polar yacht *Blencathra*, who took upon himself all the risks of the financial side of the question. He was the owner of the lost steamer *Stjernen*, not covered by insurance. Notwithstanding which, Mr. Popham is equipping a new expedition to the Yenisei in 1895. To all that has been said above, I must add that a vast number of Norwegian craft have been sailing on the Kara Sea for now more than twenty years, engaged mainly in the walrus fishing industry. These vessels cruise over the Kara Sea in all directions, going as far north as nearly to Cape Cheluskin, passing through all the three straits and sometimes also doubling Nova Zembla from the north. From 10 to 12 such vessels make annual voyages, keeping to sea for from two to three months, thereby proving the perfect possibility of crossing the Kara Sea in all directions, with sail power only.

Thus the total number of trading vessels sailing during the past twenty years in the

Kara Sea may be estimated at a figure not lower than 200. Adding to them the vessels which have taken part in the expeditions, of which I have already had the honour to speak, we obtain more than 230 vessels sailing in the Kara Sea during the period from 1874 to 1894.

Passing to the conditions which vessels must satisfy for navigating the shores of Siberia, through the Kara Sea, I must observe that all ordinary steam trading vessels may be suitable for the purpose, with only a few unimportant additions to their equipment and construction, such as it is known, are introduced in vessels foreseeing the possibility of meeting with ice. But it is essentially important, and I consider it necessary to direct the especial attention of my hearers to this circumstance, that steamers of ordinary construction should be convoyed by a steam vessel of special type and build, for investigating the state of the ice and indicating the course over the Kara Sea; and, in case of need, for affording necessary assistance.

Here I show general views of the steam whaler *Labrador*. This steamer is built entirely of the very stoutest oak and teak, they have a double sheathing of very thick planks (of 3 to 4 inches) and are strongly fastened on the inside with massive knees and crossbeams, these fastenings being very numerous in the bow, doubled outside entire length of vessel with thick oak plank. Besides this, in the bow, above the sheathing, is placed lengthways from the stern for 12 to 15 feet, a triple covering of thick planking which is sheathed with thick iron plates, reaching at the stem as much as 7 inches in thickness, and diminishing at the after part to 2 inches, forming thus a "ram" capable of cutting into thick drifting ice, and forcing through it. The remaining part of the hull is sheathed with iron plates, about ½ inch in thickness, say for 8 to 10 feet below, and about 1 to 2 feet above the load-line. Such vessels should have very powerful and strong machinery, constructed with a view to stand shocks and high pressure; the propeller should be removable by hoisting-gear, and there should be as large a reserve of them as possible, as well as of certain parts of the mechanism most exposed to the risk of breakage. The speed made by such a special type of vessel under steam may be considered quite enough if it reach 10 to 12 knots. Passing to the question of the fuel supply with which such a steam vessel should be furnished, and bearing in mind its special adaptation for all kinds of explorations, for descriptive, scientific, and all other kinds of practical methods of investigating the physical conditions of navigation in the Kara Sea, this supply should be fixed at for not less than three to four months, which would correspond to the average duration of the navigation season in the Kara Sea. Furthermore, such a vessel should be furnished with sailing power to such an extent as to enable it to make passages without the aid of steam in case of machinery being broken down.

This is the reason why the participation of the steam yacht *Blencathra*, especially fitted out for Arctic navigation, was of such importance in the voyage of the ordinary freight steamers *Orest* and *Minusinsk*, in 1893, to the estuary of the Yenisei with cargoes of rails.

From these considerations I proposed, and Captain Dobrotvorsky, upon whom lay the heavy responsibility for the success of the naval expedition ships entrusted to him in the same year, accepted assistance of this kind from the yacht *Blencathra*, which was at my disposal.

Every sailor will easily understand, after all that has been said on the conditions of navigation in the Kara Sea, to what risks and contingencies Captain Dobrotvorsky would have exposed the vessels of his expedition if, from a misplaced enterprise in such a matter, he had not accepted the services I offered him, which he did not seek. It should not be forgotten that, of the three vessels in Captain Dobrotvorsky's expedition, only the twin screw steamer *Lieutenant Ovtsyn* can be regarded as sea-going, although of very small displacement; while as far as concerns the *Lieutenant Malygin*, this is nothing but a shallow river steamer, of slight construction, and the *Skuratov*, although a stout craft, is an ordinary iron barge, well fitted with sails but incapable of independent navigation, which is confirmed by the fact that she was in tow from Glasgow to her destination.

I am proud to re-call that the late Emperor, Alexander III., took a warm interest in the question of this Kara Sea passage, and deigned to mark his approval of this our voluntary service by the bestowal of an Imperial gift. This magnificent and significant gift I look upon as a national one. And as such I have resolved to place it in the loan exhibition of one of our national museums where my fellow countrymen may admire it at all times, and see in it the expression of the enlightened magnanimity of the deceased Emperor.

Now permit me to direct your attention to the trade relations by this sea route with the European parts, as depending upon the developments and the requirements of Siberia, especially if this route be looked at in connection with the rapid construction of the great Siberian railway. This grand route, lying almost along one parallel of latitude, will connect the Baltic ports with the Pacific Ocean, over the immense extent of about 7,000 English miles. The construction of this railway completes the railway belt around the earth.

The honour of forging this last link, uniting all the routes of the world, has fallen to the lot of Russia, and if regard be had to the speed and completeness with which this enormous undertaking is being pushed forward, it is not necessary to be a prophet in order to foresee that this gigantic enterprise will very soon be brought to a conclusion.

This rapid method of communication between the immense stretches of Siberia will undoubtedly quickly infuse new life into this region, so generously endowed by nature; people of all conditions will of course crowd thither; enterprises of every kind will arise. The productivity of the country will rapidly develop with the growth of the population, and the question cannot fail to present itself, will the railway be capable of satisfying all the demands of a life so fast developing in all its manifestations? The wealth of Siberian gold-mine owners is proverbial, therefore this capital, which is now lying semi-dormant, will circulate a thousand-fold, labour being the only thing required. If we regard the immense growth of agriculture, mining, and other industries which will spring up, it is impossible to avoid the fear that one railway will be incapable of satisfying the increasing demand for the means of transport. In particular, the export of grain to Europe would rapidly increase, but only on the condition of a cheap sea freight. It may be supposed that the traffic of goods from the far East, such as tea and other valuable articles, of the mails, and of passengers will prove so great, that it may monopolise the whole capacity of the line. The growth of the population in Siberia will also call forth a greatly increasing demand for the carriage of bulky goods, such as machinery for the rising factories and agriculture, as well as for articles of ordinary household use; in fact, the sea route, in conjunction with the rivers intersecting Siberia, traversing the richest localities, alike in respect of agriculture and mining, will call forth a vast diversion of its productions—*i.e.* export of goods—and will greatly stimulate the commercial activity of the country.

Looking seriously into this matter, it is impossible not to come to the conclusion that it is necessary to promote and vigorously prosecute this Kara Sea route to Siberia at once, so that it may work in conjunction with the Siberian railway.

The system of delay, instead of steady and unceasing investigation, may lead to exceedingly undesirable and unfavourable results; the life called into being by the railway may not receive sufficient satisfaction, and then it will be necessary to make good the time lost in the establishment of the sea route by a hasty show of energy, such as almost always involves erratic work, superfluous expenditure, and unavoidable mistakes.

Nature having endowed Siberia with the richest system of rivers, indicates without ambiguity the sea route as the most suitable and, economically, the most advantageous for its communications with Europe, which may, and probably will, assume very extensive dimensions.

It is with particular pleasure that I dwell upon the steps taken by the Ministry of Marine for the exploration of this sea route—by the despatching thither annually their naval officers for hydrographic work. Many exact surveys have already been taken, and if the parties engaged had at their disposal vessels of a special type, corresponding to the difficult and complex conditions of hydrographic work in those localities, I am certain that the majority of the straits and entrances to the rivers would be quickly and exactly determined, and improved maps of these localities would be published by the Hydrographic Department. Then, perhaps, this sea route will prove even more open and free for navigation than we expect. Vessels from all European ports—Russian and foreign alike—would establish a lively trade, and would combine their efforts with those of the great Siberian railway to a mutual advantage.

The present Emperor has deigned to retain the presidency of the committee for the construction of the Siberian railway, which indicates that he devotes himself with especial love to this great international work. This august example should serve as an incentive and encouragement to the lively activity of all true Russians, commencing with ministers who can call forth talent and capital, and thus

quickly complete this great enterprise of our age, so that it may constitute one of the brightest pages of Russia's history, and that the last link in the iron girdle or belt encircling our earth may not only be "forged," but, what is of much more importance, be fast "welded," realising thus the hopes of the people, and sealing for all time the glorious fact that Siberia, now the Land of Exile, will be opened to do active commerce with all the world.

In conclusion, I feel it but a duty to draw your attention to the significant fact, that not only have men dared the dangers of the seas in order to demonstrate the feasibility of navigating these waters, but even brave ladies have successfully made this voyage, with pleasure and gratification to themselves. Miss Peel—who has written a book, "Polar Gleams," on the history of this voyage—with Mr. and Mrs. James, accompanied us in Mr. Popham's arctic yacht *Blencathra* to the port of Golchikha, at the entrance to the River Yenisei, returning to England *viâ* Archangel and the renowned fiords of Norway, 1893.

This historical record of the courage and hardihood of our British dames has been somewhat eclipsed by a brave couple of Siberians, born in Yeniseisk—young Mr. and Mrs. Vostratine, gold-mine owners — who, as a diversion, determined to make a circular wedding tour from their native city. Proceeding overland by sledge during the winter they visited Moscow, St. Petersburg, Paris, and our metropolis, and joined our yacht *Blencathra* at Newcastle last season, proceeding direct with our late steamer *Stjernen* to our port on the Yenisei, and finally up river some 2,500 miles to the very door of their own charming home in the Siberian city of Yeniseisk. Surely we must now consider this questionable sea route as being open to the world, seeing, as we do, the pleasant fact that ladies of tender birth have accomplished with ease and great pleasure, that which has been the task of my life, *i.e.*, a Kara Sea voyage to central Siberia.

DISCUSSION.

Captain WIGGINS, in answer to several inquiries, said the fuel used on the steamers was wood, of which there was an abundant supply on the river, some of it very resinous. An immense timber trade could be carried on there, as the timber could be cut and floated down in rafts at four or five miles an hour. He had seen birch planks, 3 feet wide, hewn by the axe. The health of the natives was generally very robust, but there were sometimes epidemics, such as small-pox, and the people also suffered from ophthalmia, caused by the smoke in the tents. He found it necessary to always lie very near the floor; if you were more than a foot or two above it you got choked by the smoke, and your eyes suffered. Some of the tents were very large, and accommodated several families; the people were prolific, and the children were very strong and healthy. They were much superior to the Esquimaux, who did not even tame the reindeer, but simply killed and ate them. The Samoyedes, on the other hand, tamed them and bred them abundantly, and it was a curious thing that when the wild reindeer came down from the north to the forests, as they did in the winter, the tame reindeer did not go off with them, but on the other hand, sometimes the owner of a herd would find that it had increased by 300 or 400 wild ones. The reindeer furnished these people with everything they needed, food, clothing, shelter, and the means of transport. They purchased tea and other luxuries from the Russians, and altogether led an independent and happy life. The nearest Russian town was Archangel; but they also went long distances up the rivers into Siberia, in boats and canoes. The summers were beautiful, and Mr. Seehohm had described seeing a rose in bloom the morning after the snow had disappeared. He could not go quite so far as that, but certainly the outburst of vegetation and flowers when the snow melted was almost magical, he had seen daffodils in full bloom in two or three days. They were kept warm under the snow, ready to burst into life directly the sun came upon them. There was an immense abundance of wild flowers and fruits, gooseberries, raspberries, currants of all kinds, and the maroschka, a very fine very much like a raspberry, but growing close fruit, to the ground. The reindeer moss also was very abundant. In the southern parts flowers of all kinds could be cultivated, and grapes might be grown if they chose; melons were grown in large quantities. With regard to the gold mining, the greater part of it was conducted in a very primitive manner; simply washing the earth in a shallow tray, and letting the refuse escape. A few years ago improved machinery was introduced in one of the southern mines, and it had proved so successful that the owner got more gold out of the mountains of tailings left by his predecessor than he could get out of the mine itself by the ordinary primitive method. Some very elaborate gold-mining machinery was sent out from London some time ago, and it would probably have been at work now, but unfortunately the owner died, and his trustees were not at present making any use of it.

Prof. C. LE NEVE FOSTER, F.R.S., asked if gold mining could be carried on throughout the year, or for what period?

Captain WIGGINS said some of the mines were worked all the year where there was sufficient

water-power, and they were able to get a continual stream of water under the ice to turn the machinery, or to make steam. But some small rivers froze solid, and some mines were distant from the river, and then they had to shut up during the winter, and only worked for six months. In answer to another question, he said the duration of the summer depended on the latitude. In Minnesinsh and Burnaoul there were eight months of brilliant summer, but in the more northerly parts the summer was limited to less than half the year. In the Kara Sea, for about two months, the sun was continually overhead, and you had the midnight sun. Even in the centre of the country the winters were very severe; Lake Baikal was quite frozen over, but all the heavy sledge work was done at that time of the year.

Mr. F. NIVEN said the remark made by a celebrated author, that the results obtained by a great traveller belonged to universal history, certainly applied to what they had heard that evening. Captain Wiggins had given them some very interesting and important facts with regard to a part of the earth of which most people were very ignorant, and this account of the Samoyedes was very significant, and it occurred to him that if he could introduce a few missionaries from amongst them, to institute an anti-grumbling society, it would be a great advantage to the British nation. He should like to ask Captain Wiggins what would be the position of the celebrated traveller, who was now so far north, if his compass could not be trusted, and how he proposed to get over that difficulty.

Captain WIGGINS, referring to the erratic and useless condition of the compass in the vicinity of the Siberian magnetic pole and the northern parts of the Kara Sea, said the traveller referred to, Dr. Nansen (should he be annoyed by it), would simply have to do without a compass. All the natives had a kind of instinct by which they could find their way for long distances across the trackless deserts without the aid of a compass, but any good navigator could determine his position by observations of the sun by day, or of the stars at night. Nansen would find much more difficulty from the ice than from the defects of his compasses.

Mr. NIVEN further inquired what was the principal object Captain Wiggins had in view in these expeditions?

Captain WIGGINS said his object was entirely the promotion of commerce.

The CHAIRMAN, in proposing a cordial vote of thanks to Captain Wiggins, said he had proved himself as skilful a lecturer as he was an explorer. It was too late to make any remarks on the commercial aspect of the question, but that was the aspect which he would ask the audience to think seriously over. One thing he would ask them to remember was, that the difficulties which hitherto had been believed to exist with regard to the navigation of these northern seas, had been overcome, for Captain Wiggins had proved conclusively that this was a practical route for commerce. England, as a commercial nation, should not lose the opportunity of taking part in the future development of Siberia, and from that point of view they must never forget how much they owed to Captain Wiggins.

Captain WIGGINS, in reply, said one fact was worth a thousand theories, and he had been simply bringing forward facts. At the same time, they could not get along without theories, and the practicability of the Kara Sea navigation had been a theory with him until he had turned it into a fact; but having proved it, he should not give it up as long as his health and strength permitted him to continue.

Correspondence.

THE CAUSE OF "DEVILS" OR PITS IN PHOTO-ENGRAVED COPPER PLATES.

These pits I believe to be due to particles of inferior metal left in the copper from imperfect refining, or forced into the plate mechanically during the rolling and hammering. The impurities, generally iron or zinc, are attacked much more rapidly than the copper, probably from local galvanic action, and the evil is intensified if the solution contain a large excess of free chlorine.

Messrs. Hughes and Kimber, the well-known firm of copper plate manufacturers, tell me that they are obliged to reject many sheets of copper on account of these specks, technically known as "spelter."

If a plate cut from the same sheet as one affected with "devils" is examined carefully by reflected light after it has been cleaned with whiting, these spots will be seen as lighter silvery specks; and if the plate is then held over the fumes of ammonia until the copper has acquired a decided tarnish, these specks will be still more easily recognised. Although I am unable—from the nature of the trouble—to state a remedy, this simple test will enable workers to avoid the trouble. Plates showing the silvery spots should be returned to the maker, they are quite suitable for mezzotint, or engraving with the burin, but useless for our purpose.

With regard to the etching solutions, it seems to me that the more simple and stable the composition of these solutions the better. The photogravure process is already hedged in with too many elements of uncertainly to render it desirable to introduce another if it can possibly be avoided. What we require is a set of solutions capable of attacking the copper evenly, and a power, under our control, of limiting the time of biting on any particular tone of the picture. A set of solutions of pure anhydrous

perchloride of iron, Fe_2Cl_6, dissolved in cold rain-water, fulfils these conditions perfectly, and can be relied upon to act with certainty, but the cost of the pure salt is prohibitive. In the "Manufacturing Chemist," I see the ordinary solid perchloride is quoted at 1s. per lb., and the pure neutral sublimed at 10s. 6d.

A solution of the commercial article will usually be distinctly acid, *i.e.*, contains an excess of free chlorine, attacking the copper with uncontrollable energy, and is liable to cause the resist to blister and rise from the plate; on the other hand, an excess of iron is undesirable, as it hardens the gelatine in patches, slows the etching, and causes the solution to attack the copper unevenly.

The commercial forms of ferric perchloride are as follows:—

1. The anhydrous perchloride of iron, Fe_2Cl_6, Mol. weight 325, prepared by passing chlorine gas over heated metallic iron. Fe_2Cl_6 condenses on the upper part of the vessel, as small, dark, irridiscent crystals, red by transmitted, green by reflected light; exposed to the air it rapidly turns yellow and deliquesces. Ferrous chloride, $FeCl_2$ will be found adhering to the remaining metallic iron as light buff scales.

2. Metallic iron is dissolved in hydrochloric acid, and chlorine gas passed through the liquid to saturation, the ferrous is converted to the ferric salt; the free chlorine is then removed by passing a stream of carbonic acid gas through the warm liquid. On evaporation, the solution yields a mass of fine yellow crystals having a formula, Fe_2Cl_6 $12H_2O$, or more rarely, a red salt, Fe_2Cl_6 $5H_2O$.

3. The liquid. The official solution of ferric perchloride of the B.P., prepared by dissolving iron in hydrochloric acid, and adding nitric acid until the black colour at first produced disappears, resulting in a very dark reddish brown liquid, its colour being due to the solution of *a* N.O. in a portion of the ferrous salt; this trace of nitric oxide renders this form the least desirable for our purpose.

If we boil a solution of Fe_2Cl_6 as recommended by Mr. Denison, some hydrochloric acid is evolved, depending on the degree of concentration of the solution, and a dark solution of ferric oxychloride remains.

Mr. Wilmer recommends boiling the dilute solution with commercial red oxide of iron. Here, again, we have uncertainty, as the commercial oxide formed by roasting sulphate of iron (Fe_2O_3) is nearly insoluble in the solution, and the change would be almost entirely the result of heat.

Freshly-precipitated ferric oxyhydrate $Fe_2O_2 2HO$ is, however, very soluble in the solution, nine molecules of $Fe_2O_2 2HO$ being dissolved by one molecule Fe_2Cl_6.*

The solution I have found most suitable is prepared by dissolving the solid salt in cold rain water; if the salt is tied up in coarse canvas, and suspended in the jar near the surface, the solution will reach 42 Baume in about 48 hours, and it will smell strongly of chlorine. Now expose to the action of the air, in a large dish (do not have more than half an inch of solution), in a well-ventilated place, and in 48 hours the solution will have become transparent, and the free chlorine have passed off. Now refilter, and make the various strengths by adding cold-filtered rain water.

The addition of alcohol seems to me also undesirable, as, unless the solution be acid, it causes decomposition, with the formation of insoluble oxychloride of iron; even if acid, the solution slowly loses colour, ferrous chloride and chlorinetted etherereal bodies being formed. E. SANGER SHEPHERD.

Oaklands, near Cuckfield, Sussex.
March 30th, 1895.

* Bloxham, "Chemistry," 1894 ed.

ROUTES BETWEEN PESHAWAR AND CHITRAL.

The country between Peshawar and Chitral, as also the districts on both sides of the main route by the Malakand and Lahauri passes, may be penetrated by roads in every direction. Thus the communications between our possible enemies on the right and left—the Buneris and Swatis respectively—are maintained, that from Buneir to Swat, by the Jwarai, Kalel, and Karikar passes; whilst Buneir has routes to the Chagarzai, Akazai, and other Yusufzai valleys, to Puran, Chakesar, Ghorband, &c. There is also the road of Chamla to Buner by Ambela or the Barando, whilst from Chagharserai, or rather Asmar, the Amir's troops could move on Umra Khan's usurped capital of Dîr by even Waigal, provided the infesting Kafirs *en route* have been really subdued or converted. Besides being circuitous, his route has the disadvantage of avoiding Manda, Barwa, and other places of Jandôl, the home of the aggressive Umra Khan. From Dîr to Chitral there is an *embarras de richesses* of roads and cross-paths by the Shushidará, reaching Ashreth in twenty odd miles (a writer in the *Times* would make the whole distance from Asmar to Ashreth only twenty miles). Buner can be overawed, if hostile, from ever so many points acting from Peshawar (by the Tanga Pass, by Swat Baizaise), or from Hoti-Mardan as a centre, viz., by Lalu, Súdúm, Baizai, (which has three bifurcations) by Sherdara, Ambel and the Chamla Valley, Chamla being also accessible by the Khuda Khel country or Koga. The once notorious fanatical Indian Wahabi settlements of Malka could not be easily surprised, except with the connivance of the surrounding tribes with whom they were not popular, say through the Jadun country. It was at Malka that the Hindustani adventurer, Sayad Ahmed, found a refuge after being turned out from Satana. Again, Hoti-Mardan is a point for expeditions into Swat (*a*) by the Malakand Pass, (*b*) by the Mora Pass, (*c*) by the Shahkot Pass.

As to the possible co-operation of Afghan troops from Chagharserai, Jelalabád can be drawn upon as a centre, for the two places are accessible by Bazarak,

[urgal, and Narang, and above all, by Kuner, where [M]r. Udny is now conducting the frontier delimitation. [T]here is said to be a direct road from Jelalabád [t]o Chitral by Baraz in twenty marches, but its [a]uthority is doubtful. The known routes are by the [K]uner and Chagharserai, as above, and by Tirgari, [b]ut we need not describe a route for the Amir's troops. [W]e are more concerned with Jandôl and with our [h]old on Bajaur generally, and especially its capital, [M]iankalái, which may also be reached by the [M]omand country—there, however, "*Quieta non [m]overe*" would be a good motto—and as above, [b]y Swat. The direct road from Peshawar to Chitral [b]y Swat and Dîr is as follows:—

1. By the Malakand Pass.

After leaving Shergarh (the last village in British [t]erritory, the frontier of which may now be pushed [o]n), some 48 miles from Peshawar, the road, especi[a]lly before reaching Shahkot, is broken, and several [r]avines have to be crossed. Nine miles beyond Dargai—a village of some 300 houses, surrounded by a wooden wall 40 feet high and 3 feet thick, and [o]ccupied by an ill-reputed people—is the Malakand Pass. Between Dargai and Kharkai is an encamp[i]ng-ground sufficient for an invading force, the ascent of the Malakand being only wide enough in places for the passage of a pair of bullocks. There are, however, here and there open spaces for camping-grounds, and, on the whole, it is the best road for troops into Swat, and is the one used by traders. The descent is in zigzags to Khar (six miles), and six miles on again, and about 1½ miles from the Swat river, we reach Aladand, the residence of the chief of the Ranizai branch of the Yusufzais. The road to Uch or Uchinai, nine miles away, a cluster of four villages, of which one belongs exclusively to Syads, goes straight for the Swat river, which is crossed on rafts. Then fifteen miles to Shamshi Khan, on the bank of the Panjkora, by an easy pass into the Talash district. Then twelve miles ahead we pass Miankalai, a town of about 1,000 houses, the largest and most important in Bajaur. The road now goes up the Jandôl valley to Kaobat, a village of thieves, worthy of the famous robber of a rifle from the Peshawar cantonment, whom we have made a power. Then a stiff ascent to the Janbatai Pass, descending to the fort and village of the same name. The usual 12 miles' march again takes you to Sarbat, by the Baraul valley, crossing halfway at Banda, the frontier of Dîr; cross the Dîr river at its junction with the Panjkora, and continue up its left bank to Dîr, thus concluding the fourteenth easy march from Peshawar. Dîr is one of the principal marts of the country, has a mud and stone fort, on a mound, protecting the village of some 400 houses. It is on the right bank of the river. Here the roads from Chitral, Swat, and Kunar meet. That to Chitral is infested with Káfr robbers, whom Umra Khan is said to have recently completely subdued. The road goes up the Dîr valley, and is rarely really open before May. A place, nine miles from Dir, Kashgarai, is now reached, and 12 miles further on we ascend the glen to Gujar, a village only inhabited during the summer months. We are now 174 miles from Peshawar, and the difficult Lahauri Pass is before us before we descend on Ashreth, 21 miles from Gujar, and can turn out Umra Khan, if he has not turned himself out before. Of course, the blue-eyed Káfrs, "the cousins of the Firangi," should help us. Much iron is found in the bed of a small stream that rises at the foot of the Lahauri mountains, and copper, and even silver mines exist to tempt European cupidity. Descend to the Kunar river in 10 miles, then ascend its left bank to Kalatak, 8 miles, then on to Darosh fort and village, where Umra Khan had recently won a victory. Crossing by the Shushidara bridge, 9 miles brings us to Shushidara, a small village on the ever-unfordable Kunar river. Continuing nine miles along its left bank Bruz village is reached, and 10 miles on again we cross it by a bridge to Chitral fort.

I hope to give other routes as occasion arises for their description. G. W. Leitner.

Woking, 23rd March, 1895.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock:—

April 24.—"The Use of Electricity for Cooking and Heating." By R. E. Crompton, Pres.I.E.E.

May 1.—"Deviations of the Compass." By Professor A. W. Reinold, F.R.S. Dr. W. Anderson, F.R.S., Vice-President of the Society, will preside.

May 8.—"The Extraction of the Rarer Metals from their Oxides." By Professor William Chandler Roberts-Austen, C.B., F.R.S.

May 15.—"Means for Mitigating the Fading of Pigments." By Captain W. de W. Abney, C.B., F.R.S.

Indian Section.

Thursday Afternoons, at Half-past Four o'clock:—

April 25.—"The Coming Railways of India, and their Prospects." By J. W. Parry, A.M.Inst.C.E., late Executive Engineer Indian State Railways. Sir Albert K. Rollit, M.P., LL.D., Vice-President of the Society, will preside.

Foreign and Colonial Section.

Tuesday evenings, at Eight o'clock:—

May 21.—"Commercial Education in Belgium." By Professor William Layton. Lord Reay, G.C.S.I., G.C.I.E., will preside.

Applied Art Section.

Tuesday Evenings, at Eight o'clock:—

April 23.—"Art of Casting Bronze in Japan." By William Gowland. Prof. W. C. Roberts-Austen, C.B., F.R.S., will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

JAMES DOUGLAS, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures.

LECTURE I.—APRIL 22.—*Mechanical Appliances and Methods in American Metallurgy.*—High price of labour in the mining districts of the United States stimulates mechanical inventions and large production —Rock breakers of the Blake and Gates types—Stamps—The California revolving drop stamp—The Ball steam stamp—The Huntingdon mill—Ore concentration—Arrangement and operation of Lake Superior metallic - copper concentration works—Montana copper concentration works—Concentration of gold by hydraulic methods—The Bucyrus steam shovel as applied to placer mining—Hendy's hydraulic lift—The automaticity of the gold mill—Records of cheap milling—Silver milling—Celerity rather than thoroughness the characteristic of the Washoe process —Comparison of the patio with the Washoe process —The Boss continuous system of silver milling.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 22 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. James Douglas, "Recent American Methods and Appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." (Lecture I.)

British Architects, 9, Conduit-street, W., 8 p.m. Prof. Aitchison and Mr. W. Young, "Marble for Decorative Purposes."

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, APRIL 23 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. William Gowland, "Art of Casting Bronze in Japan."

Royal Institution, Albemarle-street, W., 3 p.m. Professor George Forbes, "Alternating and Interrupted Electric Currents." (Lecture I.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Statistical, Geological Museum, Jermyn-street, S.W., 5 p.m. (in the Royal United Service Institution, Whitehall, S.W.). 1. Mr. E. W. Brabrook, "Progress of Friendly Societies, 1884-94." 2. Rev. J. Frome Wilkinson, "Some Illustrations of Friendly Society Finance."

Photographic, 50, Great Russell-street, W.C., 8 p.m.

Sanitary Institute, 74A, Margaret-street, W. 8 p.m. Professor Henry Robinson, "Sewerage and Sewage Disposal."

Antiquaries, Burlington-house, W., 2 p.m. Annual Meeting.

WEDNESDAY, APRIL 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. R. E. Crompton, "The Use of Electricity for Cooking and Heating."

Geological, Burlington-house, W., 8 p.m. 1. Sir Henry H. Howorth, "The Shingle Beds of Eastern East Anglia." 2. Prof. W. J. Sollas, "Mode of Flow of a Viscous Fluid." 3. Mr. H. M. Bernard, "Supplementary Notes on the Systematic Position of the Trilobites."

Mechanical Engineers (in the Theatre of the United Service Institution, Whitehall) 7½ p.m. 1. Discussion on Captain H. Riall Sankey's paper, "Governing of Steam-engines by Throttling and by Variable Expansion." 2. Third Report to the Alloys Research Committee; by Prof. W. C. Roberts-Austen. 3. Mr. Allan Gibb, "Appendix on the Elimination of Impurities during the process of making 'Best Selected' Copper." 4. Mr. Alfred Stansfield, "Appendix on the Pyrometric Examination of the Alloys of Copper and Tin."

Royal Society of Literature, 20, Hanover-square, W., 4½ p.m. Annual Meeting.

Botanic Gardens, Regent's - park, N.W., 2 p.m. Second Spring Exhibition.

Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. 1. Mr. A. C. Claudet, "Mining and Milling at the Mesquital del Oro Gold Mine." 2. Mr. A. J. Mactear, "Dry Blowing by Hand."

North-East Coast Institute of Engineers and Shipbuilders, Fawcett-street, Sunderland, 7.40 p.m. 1. Discussion on Mr. S. O. Kendall's paper, "Turret-deck Cargo Steamers." 2. Mr. G. H. Baines, "The Metric System of Weights and Measures."

THURSDAY, APRIL 25 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. J. W. Parry, "The Coming Railways of India, and their Prospects."

Royal, Burlington-house, W., 4½ p.m.

Chemical, Burlington-house, W., 3 p.m. 1. Prof. Tilden and Dr. M. O. Foster, "The Action of Nitrosylchloride on Amides." 2. Prof. Tilden and H. J. Marshall, "The Action of Nitrosylchloride on Asparagine." 3. Mr. L. T. Wright, "A Property of the Non - luminous Atmospheric Coal-gas Flame." 4. Messrs. A. G. Perkin and J. Geldard, "A Constituent of Persian Berries." 5. Messrs. E. Divers and T. Haga, "Potassium Nitro - sulphate." 6. Mr. J. J. Sudborough, "Diortho-substituted Benzoic Acids;" "Hydrolysis of Aromatic Nitrites and Acid Amides;" "Action of Sodium Ethylate on Deoxybenzoin."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Liquefaction of Gases." (Lecture I.)

Electrical Engineers (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Prof. J. A. Ewing, "A Magnetic Tester for Measuring Hysteresis in Sheet Iron."

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, APRIL 26...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. J. Hopkinson, "The Effects of Electric Currents in Iron on its Magnetisation."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. H. Percy Boulnois, "Scavenging and Disposal of House Refuse."

Mechanical Engineers, in the Theatre of the United Service Institute, Whitehall, 7½ p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science Schools, South Kensington, S.W. 5 p.m. 1. Mr. W. G. Rhodwell, "A Theory of the Synchronous Motor." 2. Mr. G. H. Bryan, "Note on a Simple Graphic Interpretation of the Determinantal Relation of Dynamics."

SATURDAY, APRIL 27...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Arnold Dolmetsch, "English Music and Musical Instruments of the 16th, 17th, and 18th Centuries." (Lecture I.)

Journal of the Society of Arts.

No. 2,214. Vol. XLIII.

FRIDAY, APRIL 26, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 22nd inst., Mr. James Douglas delivered the first lecture of his course on "Recent American Methods and Appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver," in which he deals more particularly with the mechanical appliances and methods in American metallurgy.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 24, 1895; William Henry Preece, C.B., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society :—

Brown, Arthur Crompton, The Laurels, Chesterfield.
Crampton, W. T., Parcmont, Roundhay, near Leeds.
Jenkins, John H. B., Great Eastern Railway Works, Stratford, E.
Jennings, Gilbert D., 28, Gracechurch-street, E.C.
Luty, Arthur, 30, Bryn-mor-terrace, Swansea.
McDonald, John, Charters Towers, Queensland, and 43, Threadneedle-street, E.C.
Markoff, Dr. Anatolius Vladimirovich, 51, Hunter-street, Brunswick-square, W.C.
Molyneux, Harry, The Kennels, Haines-hill, Twyford, Berks.
Norman, John Thomas, 78, Chelverton-road, Putney, S.W.
Penny, John A., 16, Wallace-road, Canonbury, N.

The following candidates were ballotted for and duly elected members of the Society.

Bevan, Rev. Cecil M., 38, Orsett-terrace, W.
Coode, John Charles, 19, Freeland-road, Ealing, W.
Duckenfield, Edwin Ernest Vernon, Gold-street, Northampton.
Hesketh, John, Osbourne-road, South Shore, Blackpool.
Skinner, John, 57, Jermyn-street, S.W.
Yule, Andrew, 19, Great Winchester-street, E.C.

The paper read was—

THE USE OF ELECTRICITY FOR COOKING AND HEATING.

By R. E. Crompton.

Up to the present time, the utilisation of electrical energy, laid on now so universally in our houses for lighting purposes, for the further purposes of heating and cooking, has been regarded by the public, and even by many who have technical knowledge, as impracticable, and certainly as too costly, to be seriously adopted.

It will be my object this evening to show you that far from this being the case, heating and cooking by electricity has now advanced to a highly practical and useful stage. No doubt these erroneous impressions have arisen chiefly from the fact that the advocates of electric lighting have from the first dinned into the ears of the public that one of the chief advantages of electric lighting is that by it light is furnished without heat; even those who put it more precisely showed that a 10 c.p. gas jet heated the air of a living room 13 times more than a 10 c.p. electric glow lamp, and it was the knowledge of these facts that prevented electrical engineers from carefully examining the problems connected with electrical heating.

However, at a very early period, Siemens showed that where intense heat is required to be concentrated in a small space, the electric arc forms a very convenient furnace, and, in many cases, actually possesses economical advantages. This principle was practically adopted by Cowles for his earlier furnaces for reducing aluminium, and has been also used for electrical welding by the Benardos process.

But for the production of the heat we require for warming rooms or for cooking food, little or nothing was done until about four years ago, for although Lane Fox was the first to point out, in his 1878 patent, that electrical heating could be satisfactorily carried out by placing the food or other materials to be heated in a vessel surrounded by a coil of insulated wire, through which a current

should be passed, nothing appears to have been attempted until about four years ago Carpenter, in America, so far developed Lane Fox's ideas as to take out a patent for manufacturing electrical heating apparatus by attaching these resistance wires to the surface of cast-iron plates by an enamelling process, and a considerable amount of apparatus was manufactured by him in America on this principle; some of this was forwarded to England and was shown at work by Messrs. Crompton and Co., at the Crystal Palace Exhibition in 1891.

In practice it was then found that although Carpenter had done sufficient to show that electric heating could be usefully employed, yet that the apparatus at that time was not sufficiently durable to be of practical value. A number of serious defects made themselves evident, principally connected with the enamelling process; the enamel was found to crack, and the surface of the wire used was thus exposed to the oxidising action of the air. This action rapidly destroyed the wire, and thus broke the circuit.

It occurred to us that this difficulty might be surmounted if sufficient time were spent on a research into the nature of the metals best suited to stand the frequent heatings and coolings to which the apparatus is subject, and which at the same time would have a coefficient of linear expansion so nearly the same as that of the enamels used, and of the plates to which the wire is attached by these enamels, that the tendency to crack, which is caused by unequal expansion, would be overcome.

After a long course of experiments, we found that several of the nickel steel alloys, varying in composition from pure nickel to others containing quite a large proportion of steel, were well suited for the purpose, and in all respects were far superior to the German silver alloys which had been used in America. We also found that if we substituted for the homogenous enamel used by Carpenter, a composite enamel consisting of two or more layers, the lower one being of the hardest and most refractory character, we were able to obtain very satisfactory results. We have been able to use an enamel consisting almost entirely of silica for the ground-work; this fuses only at an exceedingly high temperature almost approaching the welding point of wrought iron. We devised special machinery to artificially roughen, the surface of the plates to which this first coat of enamel is to be applied, and we thus insure that the layer of enamel between the wire and the plate, to which it is attached, is never even softened at the temperatures reached by our apparatus in ordinary working. We apply our nickel steel wire in the form of a waved or crimped ribbon. This crimping is carried out by a special machine devised for the purpose.

This crimped ribbon is mounted on the surface of a "transfer plate," afterwards to be described, and it is from it transferred to the surface of the first coat of enamel, which has been already raised to a temperature sufficient to soften it but not to melt it. We then cover the first enamel and the wire with powdered enamel of a more easily fusible nature, and we then raise the temperature of the whole to a sufficient degree to enable the second enamel to melt down and incorporate itself with the upper surface of the first coat of enamel, at the same time completely covering and insulating our wires. This process is one which has required much study and considerable manual dexterity on the part of the workmen, but when once it was perfected it gave excellent results; it allows the wire to be heated to any degree desirable for ordinary heating or cooking operations, without any fear of the enamel cracking so as to allow of access of air to the wire.

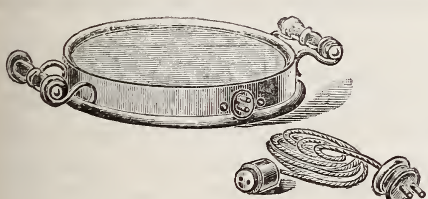
Not the least part of our difficulties was the preparation of the crimped wire and the designing of the transfer plates above referred to. We found that if we attempted to crimp the wire or arrange it in wavy patterns by hand, that the wire was always liable to become thinner at each of the bends, and consequently the electrical resistance at these points was higher, and the heat developed greater than that of the points intermediate between the bends. To avoid this we had to devise a crimping machine, which crimped or corrugated the wire in such a manner as to avoid altering its cross section. This machine takes the wire from a reel, crimps it, and delivers it in any desired pattern on to the surface of the transfer plates.

The transfer plates consist of a metal plate, to the back of which are attached a number of electromagnets, in such a manner that when the crimped steel wire has been laid on its plate, in any desired pattern or form, by exciting the electromagnets, they hold the wire and retain it firmly in position on the surface of the plate until it is desired to transfer it to the heated surface of the enamel; this can be done instantaneously by breaking the exciting circuit, so that the wire no longer adheres to

the transfer plate. We have other methods of rapid transfer, but it is unnecessary to take up your time by describing them here, as the above method is fairly representative of the others.

By the above-described method we are able to apply the wire in somewhat complicated patterns to the surface of any metal plate, and to insulate it therefrom in a very thorough and permanent manner by our compound enamel. The only other difficulties which have arisen in connection with the enamel have been those due to unequal expansion and contraction of the terminals at the ends of the wire. At first we had some difficulty in arranging these so that the enamel did not crack, and thus allow the terminals to be burnt or oxidised at the point at which the wire leaves the enamel.

The simplest form of apparatus in which we heat a plate by a current passing through a wire enamelled to its surface, is that which we call a heater. It is a circular plate mounted on short legs, to the underside of which wire is applied and fixed by the enamel, the upper side being ground flat and polished. Such a heater may be put to many useful purposes; it can be used as a radiator of heat



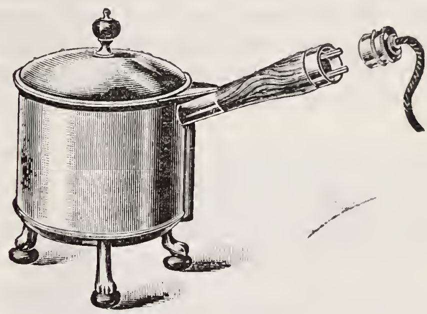
Electric Heater.

or as a means of heating dishes on the breakfast table, or for the purpose of drying linen or for warming or drying any article which it is inconvenient or dangerous to place near the fire. It can also be used for cooking purposes if the food is placed on flat dishes or pans, care being taken that the lower surface of the pan comes into close contact with the upper surface of the heater; but, although cooking *can* be carried out in this manner, we do not recommend the use of separate heaters, as there is always a loss from the lower surfaces of the pans not making sufficiently good contact with the upper surface of the heater, and we therefore prefer to insure this contact by making the heating-plate form part of the kettle, saucepan, frying-pan, or other similar culinary utensil.

In the course of our experiments to determine the best and most efficient arrangements of our apparatus we met with great difficulties in what would appear a comparatively simple matter—the measuring of the temperatures we obtained. We found that the ordinary mercurial thermometer, however carefully it may be made, is not suitable for accurately indicating the

Electric Frypan.

temperature of the heated surfaces, as it really indicates the temperature of a stratum of air near to the heated surface instead of that of the surface itself. After trying Callendar's improved form of the Siemens electric pyrometer we eventually adopted for our measurements of temperature my own form of platinum thermometer, a description of which may



Electric Saucepan.

interest you at this stage. This platinum thermometer, which measures temperature by showing the increase in resistance due to the rise in temperature of a delicate coil or platinum spiral placed in close contact with the heated surface, is made and used as follows.

The spiral consists of a thin strip of platinum only two-thousandths of an inch thick by one twenty-fifth of an inch wide; a sufficient length of this strip to have about five ohms resistance at the temperature 0° Cent. is wound in a form of double spiral on to a strip of mica sheet about half-an-inch wide by four inches long; this is enclosed and held between two similar sheets of mica fastened together at their edges by a sewing of very fine platinum wire. The total thickness of the spiral and its covering is not greatly in excess of that of a sheet of paper, so that the whole of the spiral can be

brought within a distance of one-hundredth of an inch from the surface to be measured. It is arranged on an electrical circuit in series with a standard resistance made of manganin. The standard made of this alloy has practically no change in resistance due to change of temperature, *i.e.*, within the limits of air temperature change of an ordinary room, or laboratory. Both platinum spiral and the standard manganin resistance are provided with couplings or terminal screws, by which any desired number of platinum spirals may be coupled in series with the manganin standard. A very small constant current from an accumulator cell is passed through the whole of them. Each of the platinum spirals, as well as the manganin standard, is provided with a pair of potential terminals, and at the time of first calibration they are carefully adjusted, so that the P.D. measured on a potentiometer is exactly equal. When the platinum spirals are plunged in melting ice and the manganin resistance is at the ordinary laboratory temperature, it is convenient to balance them at this point at 1,000 on the potentiometer scale. The platinum spirals are then exposed to the temperature of boiling water in a hypsometer, and if the platinum employed be pure, the P.D. of the platinum spirals, when now compared with that of the standard, will be as 1,362 : 1,000. If this portion of the potentiometer scale between 1,000 and 1,362 be divided into 100 parts, each of these will be equal to 1° Cent. It is evident that any desired number of temperature readings may be taken by employing a corresponding number of platinum spirals, and comparing them in turn with a standard.

It is obvious that this method of taking temperatures presents many advantages over the employment of ordinary thermometers, as when these have to be used for taking temperatures of ovens or of the interior parts of meat, or of other food, the act of removing the thermometers to take the reading introduces errors of considerable magnitude, whereas, with the arrangement I have just described, it is possible to take accurate readings, practically simultaneously, of the temperature in various parts of the oven or other apparatus, and of various parts of a joint of meat, and in this way a great many interesting facts respecting cooking have come to light. By these means we have been able to measure, with a high degree of accuracy, the amount of electrical energy that is required for various forms of heating and cooking apparatus, and the following four Tables give a fair idea of the

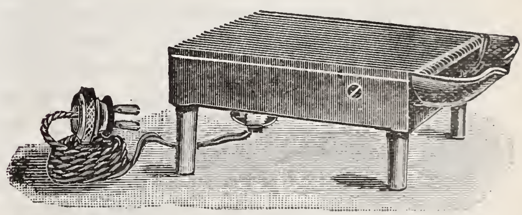
	Time.	Energy in B.O.T. Units.	Cost at 4d. per Unit.	Temperature Fahr. scale.
TABLE I. Showing energy required to raise a heater plate from 50° Fahr. to 400° Fahr. in half an hour.	0	0	0	50 deg.
	10 mins. ..	0·116	·46d.	257 ,,
	14 mins. ..	0·164	·67d.	332 ,,
	21 mins. ..	0·248	1·0d.	357 ,,
	30 mins. ..	0·404	1·61d.	400 ,,
TABLE II. Shows the energy required for a radiator plate, such as we use for heating the air of a room.	0	0	0	50 deg.
	10 mins. ..	0·091	0·364d. ..	171 ,,
	30 mins. ..	0·277	1·1d.	240 ,,
	40 mins. ..	0·350	1·4d.	257 ,,
	50 mins. ..	0·430	1·72d.	261 ,,
	60 mins. ..	0·500	2·0d.	264 ,,
TABLE III. Shows the energy required for boiling 1 lb. of water in a tea-table kettle.	0	0	0	50 deg.
	18 mins. ..	·075	0·32d.	212 ,,
TABLE IV. Shows energy required by a smaller kettle containing ¾ lb. of water, *i.e.*, sufficient for two cups of tea.	0	0	0	50 deg.
	12 mins. ..	·051	0·2d.	212 ,,

cost of heating of surfaces required, first for roasting, or baking, or frying; the second Table gives the cost of heating surfaces to a lower temperature, such as is required for warming the air of a room, or for airing linen, or similar purposes; Tables III. and IV. give the cost of the energy required for boiling water in small quantities, and are interesting, as they show that even when we are using electricity in the manner in which it compares least favourably with solid fuel, *i.e.*, for the boiling of water, we can, with an ordinary electrical kettle, switch on the current and obtain a cup of tea at a cost of less than a farthing for a single cup, or half a farthing per cup, if several are required.

ELECTRIC KETTLE.

Although these Tables show the amount and cost of electrical energy required to raise various kinds of heating surfaces to a certain temperature, something more than this is necessary to enable you to form an opinion of the value of heating and cooking by electricity from the point of view of economy.

When the subject is first mentioned even to a skilled engineer, his first idea is that in almost every case electric heating must be too expensive to become general. He knows the wastefulness of steam generating plant is such that not more than 6 per cent. of the heat energy in the fuel can be distributed to the consumer in the form of electrical energy, and he is not to be blamed if he concludes from this that there is no chance of using the re-converted heat from this energy, in competition with the heat which the consumer can obtain direct from burning the fuel itself. But the fact is that all these opinions are based on an insufficient knowledge of the economy—or rather extraordinary *want of economy* of cooking—as carried on at present by the ordinary kitchen grate. Now that we can actually measure the heat that is required to carry on cooking operations, we are astonished at the smallness of the results obtained by present methods. The per-centage of the heat-units of the coal burnt in our kitchens which is actually utilised in cooking the food is in all private houses, and in most hotels and clubs, so ridiculously small that I should hardly be believed if I quoted you the figures which we have obtained; it is not too much to say that in many cases not more than 2 per cent. is utilised. This enormous waste is due to the fact that with the sole exception of boiling and stewing all the remaining operations of cookery depend on the radiation of heat to the substance to be cooked. Take, for instance, the process of grilling a chop, consider how much coke has to be burnt before a bed of glowing coke fit for the purpose is obtained, and after the clear grilling fire is in order, consider that 80 per cent. goes up the chimney, 16 per cent. is radiated into the room, or employed in roasting the cook, male or female, as the case may be, it is not difficult to understand that the chop itself does not receive more than 2 per cent. of the total heat-units. On the other hand, with a properly-arranged griller, heated by electrical means, fully 70 per cent. of the heat energy in the electricity is utilised in the meat. Take, again,



ELECTRIC GRILLER.

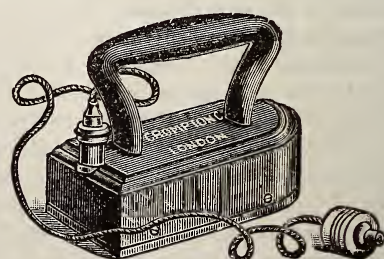
the case of the ordinary oven attached to the kitchener of a small private house. The oven may be used, on an average, three hours a day, but if solid fuel is used the oven must be heated continuously from the time that the kitchen fire is alight in the morning until late at night, so that in this case the total heat usefully radiated from the sides of the oven to bake, to roast, or brown the food within it, generally amounts to a very trifling percentage of the fuel used.

The comparison with gas cooking, although not so striking as when solid fuel is used, is still very favourable to electricity, for, although in the case of the gas oven, considerable economy results from the gas being used only at the time that the oven is required

for cooking, yet in this case the heat is communicated to the food by radiation from gas flames, so that it is necessary that a current of air continuously pass through the oven in order to ventilate it, and carry away the products of combustion. This ventilating current also carries away with it at least 80 per cent. of the heat-units obtained by burning the gas.

The electrical oven consists, as you see, of a rectangular box, having double sides at bottom, top, back, and front; the inner surfaces of the inner plates are the electric radiators, and the space between them and the outer plates is filled with a non-conducting material; the door closes practically airtight, no ventilating current of air is necessary, thus all waste of heat being prevented. In this case, when the oven is filled with food, more than 90 per cent. of the heat energy can be utilised, and thus, although possibly 5 to 6 per cent. only of the heat energy of the fuel is present in the electrical energy—90 per cent. of this—or 4½ per cent. of the whole energy actually goes into the food, and thus the electrical oven is practically twice as economical as any other oven, whether heated by solid fuel or by gas. Thus far I have dwelt at some length on the economical question: it is time to say something on the questions of the convenience and of the superior results which can be obtained by the electrical means. I have already spoken of the large loss by radiation which occurs when solid fuel is used, or to a less extent when gas fuel is used; this has the great inconvenience of injuring the quality of food that is being prepared in the kitchen, of keeping the cooks in a heated and unpleasantly perspiring condition, and I might enlarge considerably on this point. The electrically-worked kitchen may be kept as cool as a dairy if it be desired, and the effects on the quality of the cooking, and on the health and tempers of the staff, must be experienced before it can be fully appreciated. I have also mentioned, in the case of the gas oven, the necessity for allowing ventilating currents of air to pass over the surfaces which are cooking. These currents of air dry up and harden and take away the flavour of the outer portions of the meat: any connoisseur can detect this in the case of joints cooked in a gas oven. With the electrical cooking, the absence of such ventilating currents and the stillness of the air prevents the above-described drying and hardening action, the meat is found to be tender and juicy right up to the extreme outer surface, it is browned only to a sufficient extent to please the eye and the palate. Again, the facility for regulating the temperature to any degree of nicety, which we can give with any of the electrical cookers or ovens, is being highly appreciated in the higher walks of the culinary art. Most skilled cooks will tell you that it takes much experience to satisfactorily manage an ordinary oven so as to bake or brown pastry or sweetmeats, and always give a uniform result. When these skilled cooks use electrical apparatus for the first time they almost invariably say—a child could learn the ways of this oven in a few hours and produce as good results with it, with absolute certainty, as I could with an ordinary oven after I had known it and learnt its ways for years.

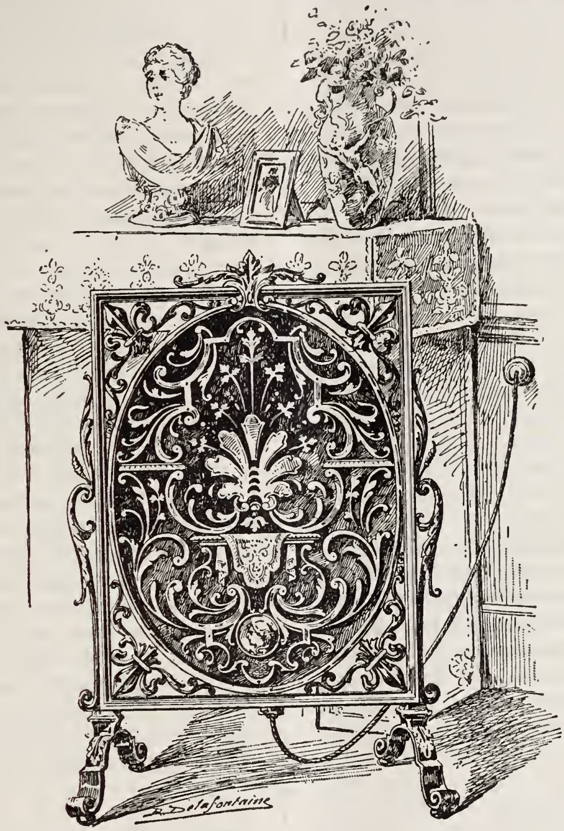
All users of electric light are interested in the development of electric heating and cooking. You all of you have been told that the cost of electrical supply may be greatly reduced, if it can be utilised during the daytime for other purposes in addition to lighting. Although the day may come—and I feel certain will come—that electricity will be used for power purposes within our homes to an extent undreamt of at the present time, yet such development must be necessarily of slow growth. We must be educated to the point of using power for many occupations and pursuits which have yet to be invented, but the day of electric cooking is not far distant. There is no reason why in a few years to come quite a majority of the users of electric light should not do all cooking operations of the nature of roasting, baking, stewing, frying, by electrical means—perhaps still employing solid fuel for boiling purposes only, and this in connection with a suitable furnace for supplying the whole of the hot water required for a household. Time



Electric Hat Iron.

does not allow me to go into very many interesting matters connected with electric welding, brazing, soldering, roasting of ores, drying of paints, and many other industrial operations

which electrical heating can be advangeously employed. I am also unable to do ore than state the bare fact that the anagers of several theatres — notably the audeville—have found that electric radiators rm a most convenient, safe, and economical ethod of heating the auditorium of a theatre. uring the late severe frost these radiators were found to be a great convenience in large shop fronts to prevent the lowering of the temperature, and hence the freezing of the moisture on the plate-glass, which otherwise obscured the contents of the windows. The apparatus, which is on exhibition in the room, is fairly representative of what is now supplied to the public.



Electric Radiator.

DISCUSSION.

The Chairman said this paper was very complete, and Mr. Crompton had told them many things which were perfectly novel, and worthy of great consideration. He had been much struck by the figures showing the absolute waste of heat which took place in every house. The public was very complacent with regard to its coal bill, and he doubted if anyone present had ever taken the trouble to see how much he paid per unit of heat utilised. After what he had now heard, he should certainly endeavour to work it out for himself. For some time he had been using one of the heating plates now shown—furnished him by Messrs. Crompton—for keeping breakfast dishes hot, it being placed on the sideboard, and it answered most admirably. There was one purpose to which the electric current could be applied, and which Mr. Crompton had not alluded. At the *soirée* of the Royal Society last year Mr. Snedekor an American gentleman, showed what he called an electric poultice—a sort of pad, inside of which heat was generated, and which could be applied in the case of a cold on the chest, rheumatism, or lumbago, the heat could be regulated exactly as required, and it could be applied just as long as was necessary. Again, in Boston, U.S.A., he had seen electricity applied to welding rails, so as to secure an absolutely perfect joint. In the Post-office there was an immense amount of sealing wax used, and as he was fitting up a large office in Leeds with electricity, he had only the previous day designed an apparatus for heating wax, thinking he had started a new idea; but he now found he had been anticipated, and should probably have to send an order to Mr.

Crompton's firm. He had recently seen a suggestion, which he thought was worth consideration, that it would be very easy to place in the service pipes conveying water twin wires, through which a current could be passed in very cold weather, so as to prevent the pipes being frozen.

Mr. GUSTAV BINSWANGER said the paper was most instructive, and all who were desirous of seeing the scope of the electrical industry extended must be thankful to Mr. Crompton for having taken up electrical cooking and heating with his usual energy. He himself had given a good deal of attention to the matter, and believed he was the first to introduce it into Englaud; and his experience coincided in the main with that of Mr. Crompton. Electrical cooking apparatus could perform what was expected of it as well as any apparatus yet made for cooking by either coal or gas, and it had many advantages over the old-fashioned methods. From the user's point of view a very important point was durability, and he generally found the first question put to him was whether the apparatus was durable and reliable. It of course depended very much on the manufacture, and Mr. Crompton's improvement of using nickel steel alloys had no doubt made a great advance in this respect; as also in discovering a wire of which the co-efficient of expansion coincided best with the enamel he used. His experience was that durability could be relied on thoroughly in apparatus made for boiling, and he could point to a number of kettles which had been in daily use for two or three years, in which the current they now consumed was exactly the same as they took when first made, showing that the resistance had not altered. The same might be said of all apparatus constructed with a large surface compared to the amount of current required for heating it, such as oven plates or radiators, but he believed some qualification must be made with regard to apparatus of small surface with a large current, such as soldering irons, and even grillers and similar articles. These sometimes broke down, but the reason was not so much the mode of manufacture as the method of using them. This kind of apparatus should be used constantly, and the current should never be left on when not in use. Radiation should be in proportion to the amount of current used, else the accumulation of heat would be too great and the apparatus would break down. Another point of great interest to the public was the question of cost. Electric cooking and heating was not dear, though this idea had got abroad, and curiously enough it had been fostered by electrical engineers themselves. To them Mr. Crompton's figures would be a lesson, which he had no doubt they would take to heart.

Mr. A. R. SENNETT asked if the heater on the table was meant to operate by conduction only, because he noticed that it had a highly polished surface, which was not favourable to radiation. The paper was extremely valuable from the fact that the author had not given a lot of figures as to the number of heat units in a ton of coal or a cubic foot of gas, but had brought his ability to bear in inventing extremely ingenious instruments for making actual measurements. Considering the small thermal capacity of an omelette, they could understand that the mass of the utensil employed in its preparation played a very important part in the economy of the process, and he took it Mr. Crompton made his utensils of the least possible weight. Not only could they be used on an ordinary table cloth, but it ought to be impressed on the public that they should be so used. The bulk of the heat wasted by ordinary methods was lost by conduction; in cooking a chop by a gas stove a very small percentage of heat went into the chop, the greater part of it went to warm the stove, He was rather surprised at what was said about ventilation in ovens, and it must be remembered that in some gas ovens the heat was employed by conduction, and there were no products of combustion, but he was always under the impression that it was necessary in all cases to ventilate an oven. He did not know what the vapours surrounding a leg of mutton were, but thought they had to be got rid of. In comparing costs, it must be borne in mind that all through the winter the kitchen had to be heated, so that the heat not utilised in cooking was not all wasted.

Mr. J. G. LORRAIN said a little more information as to the insulation of the wires would be very useful, as he understood Mr. Crompton employed the principle first enunciated by Mr. Crookes, of using what was called an "expansion pair," that is he used more than one kind of enamel. He believed Mr. Crookes used a platinum wire, and an enamel having a co-efficient of expansion very similar. He believed Mr. Binswanger, instead of using an enamel of that kind, used a paste which he put on cold, or spread with a knife after the wire had been put in position.

Mr. LESLIE MILLER called attention to the merits of ordinary incandescent lamps as heat radiators, giving out as much heat as a piece of metal, or anything else which consumed the same energy; and having the advantage of having very little bulk to be heated. Many people thought incandescent lamps gave out no heat at all, but this was a great mistake.

Mr. JENSEN asked whether electric heating had been applied to ordinary offices and dwellings, and how it would compare, in respect to cost, with heating by an open fireplace.

Mr. H. J. DOWSING said he had been connected with the manufacture of this apparatus from the commencement, and had become acquainted with both its advantages and defects, but he found it very difficult to make those who did not understand electricity, understand the best way of using it. The electric oven produced the heat inside like a gas

en, not only at the bottom, but all round—top, les, and back. At the side there were five switches which corresponded to gas taps), by which the current could be turned on to any part of the oven. The ook was now probably using only two, the top, ick, or side, according to the part of the meat quiring most heat. In roasting on a spit you rned the meat round, but there was no need for at here, because you could have the heat all round e joint, just as it was required. If there were too uch heat at any part, you did not open the door and t it out, but simply turned it off. If electric heatg were used in the same wasteful manner as heat om coal, it would be very expensive, but by not roducing the heat you did not require, economy was ffected, and you could afford to pay a higher price or what you actually used. With regard to the entilation of ovens, in the case of gas it was necesary to carry off the products of combustion, and ertain foods, such as game, must always have a ittle fresh air admitted; but a very eminent uthority, the late Mattieu Williams, said there was othing came from mutton which would injure that mutton, and he recommended cooking without ventiation. Count Rumford also, who paid a great deal of ttention to cookery, and fed the Bavarian army for some nonths, constructed an oven in which no ventilation was required. Sometimes it was necessary to let out a little steam, but not to admit anything like the amount of cold air which was generally admitted from the bottom of a gas oven. With regard to the cost of heating buildings by electricity, it would naturally cost more to produce one unit of heat in this way than by direct combustion, but if you could use it to greater advantage, as in the case of an oven, you could afford to pay a higher price, and to do with a less quantity. In theatres it was only necessary to warm the auditorium; if you warmed the floor, the heat was produced just where it was wanted. The Lessees of the Vaudeville Theatre applied to them in the very cold weather, and four electric radiators placed in the stalls, and kept going a certain part of the day, produced an immense difference. A further order was given, other radiators of a different form were placed round the sides, forming a skirting of radiating plates, which simply had to be connected by wires to the ordinary lighting circuit. A lower charge was made for the current for this purpose, and the cost was not found excessive. For a large building to be constantly used it was doublful if they could compete with coal burned in a fireplace; but it was quite possible to compete with hot-water systems; and the depreciation of the radiators would be nothing compared with that of pipes, which rusted out in the summer when they were not used. A radiator would take care of itself; it very seldom broke down, and required no knowledge how to use it. With boiling apparatus it was different. If you allowed a kettle to boil dry, the bottom would get red hot, and it might be damaged; but why should a kettle of that sort be allowed to boil dry any more than any other? People saw a kettle on the fire, and generally knew when there was water in it, and with an electric kettle they should see if any steam was coming off. With some of the larger apparatus you did not see the steam, but care should be taken; when damage arose, the fault was not with the apparatus, but with the management. In electric ovens, it was usual to turn on all the switches for about a quarter of an hour at first to get the oven heated, then the joint was put in, and a very small portion of the heating surface would then provide sufficient heat to maintain the temperature, because the heat could not escape. They had also invented an automatic switch, which could be attached, and prevented the possibility of overheating. The cook could turn on the current, put in the joint, and go away, return in three hours' time, and find it perfectly cooked. When the oven got too hot, the switch acted automatically and turned off the current, only leaving sufficient to maintain the temperature constant. The chairman had referred to heating blankets; and they had such things, though they were not exhibited. The great principle was conduction with electrical cooking apparatus, not radiation; and therefore, for cooking, you wanted the best possible contact — a very small film of air between the kettle or saucepan and the top of the apparatus would reduce its economy nearly 20 per cent. The best way was to make the apparatus complete in itself, and there was no objection to this when everything was so absolutely clean. There was no smoke, dirt, or soot. Their agent in Paris had some most elaborate designs, and had just supplied a a kettle stand costing £40 to a Russian grand duke. They could not sell such things in England yet; in fact, their own customers preferred to go to Paris, and buy from their agent there, and bring the apparatus back to England.

Mr. SENNETT suggested that some kind of signal should be attached to the apparatus so that cooks might be sure of having sufficient heat, and that heat applied in the right portion of the oven.

Mr. CROMPTON said that things which required concentrated heating, such as cigar lighters, were amongst the first things made, and they were often out of order, because people left them on, but they were now made so as to show a light as a danger signal. It was not necessary, generally, to provide these signals, as had been suggested, because cooks were decidedly above the average in intelligence, and learned how to manage the apparatus very readily. Any case of a kettle burning out generally took place in the drawing-room. On the the question of durability generally, he might say that from the beginning up to the present time the one great improvement had been in making things more economical, and, at the same time, moi durable; although, in a certain sense, these

things conflicted, because you could get more durability if you made them less economical. They had now got an apparatus as durable as could reasonably be wished, and such damage as occurred was generally due to carelessness. He agreed with Mr. Binswanger that the difficulties which remained were in the apparatus, where concentrated heat was required, such as cigar-lighters, soldering-irons, and so on. He had been experimenting for some years on this question, and had produced fairly good results, but it was an immensely difficult problem to heat wires and keep them continuously heated to a very high temperature without considerable wear and tear going on. Some progress had been made in that direction, but none of such apparatus was yet sufficiently advanced to be spoken of in the same breath with the cooking apparatus which was practically perfect. He had made electric blankets or poultices, such as the Chairman had referred to, but there was one difficulty about it. It was very easy to make an electric application for use in rheumatism or lumbago which would last for a few days, but it was very difficult to keep it in order unless it were made waterproof, and no material had yet been discovered which was both waterproof and perfectly inodorous when heated; and if it were not waterproof from perspiration and other things the wires would rust, and it would break down. He had no doubt that before long the desired material would be forthcoming. Mr. Dowsing had answered many of the questions put, and he must say that to him very much of their success was due. That success mainly dated from the time when they began to make quantitative measurements. It was just like electric lighting, so long as they paid no particular attention to measuring the quantity supplied and the cost of it, so long was electric lighting expensive; the great reduction in cost dated from the time when they made accurate measurements. The same with heating. The thermometer he had described had been a great help, and he was greatly indebted to the researches of Callender, Griffiths, Clark, and others at Cambridge, who really made the Siemens' pyrometer into the splendidly useful thing it was. The re-invention by Callender of the platinum thermometer had been one of the most remarkable things of the last few years, as it enabled one to learn infinitely more of the thermic questions which entered so largely into our daily lives than was possible before. One of the reasons they had been able to do so much in the cooking line was that they were able to discover what a remarkably small amount of heat was required. It was astonishing, in many cases, how little heat was required to effect a given object. In order to sleep comfortably on a cold night in a cold room, about one-tenth of the electricity required for an 8 candle lamp, properly applied, would enable you to dispense with three-fourths of the bed-clothes. Such a result would have been expected by anyone who thought deeply, but most people did not think deeply on economical questions, but built a fire to warm the roc and spent about a million times the units of h absolutely required. With regard to the in lation resistance, he believed the resistance of enamel was very high indeed—many megohr The leads were not enamelled, and they had to made of material which would stand a very hi temperature, which was not an easy matter. Th had succeeded in carrying it out very greatly by usi air insulation, porcelain rings, and that kind of thir Asbestos was very unsatisfactory. When he fi began to investigate this matter scientifically, t first man he went to was Mr. Crookes, a asked him what enamel had a co-efficient of expa sion most nearly resembling that of nickel wi It was due to the books he lent him that was able to start fair on this matter. The extr ordinary amount of radiation obtained from an i candescent lamp filament had been mentioned, a was quite true. The same lamp which you cou hold in your hand, or put in your mout if put into an enclosed cavity, so that t whole of its radiation was continuously receiv on the walls of that cavity soon made them ve hot. It was a pretty experiment to take a piece copper, drill a $\frac{1}{8}$-inch hole in it lengthways, and dro into it a little lamp, such as is used by dentists; in little time it would make the copper red hot. If yo could only confine radiation within certain limits, yo could get any temperature you required, howeve small the energy you had to start with; it was mere question of time. The most difficult questio to answer was the comparative economy of heatin ordinary offices or dwellings with electricity. Whe electricity was made from coal, in most cases, fo regular heating, there could be no competitio with the direct use of fuel, if it were properly applied but in nineteen cases out of twenty, it was no properly applied; and in many cases the heat wa not continuously required, often only for certai parts of the day. In those circumstances electri heating could often compete satisfactorily, just as lectric lighting competed most favourably with gas where intermittent use only was required.

The CHAIRMAN, in proposing a vote of thanks to Mr. Crompton, said he had given them an eminently practical paper, and brought forward the hard facts of the case. It was remarkable how men of wealth and position would hesitate, on the score of expense, to lay out a few pounds on electric appliances, when they would not hesitate at hundreds when buying pictures or articles of *vertu*. It was only when practical men like Mr. Crompton put the real facts before them that they were able to see that after all there was great economy in the practical application of electricity to domestic matters.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

PARIS INTERNATIONAL HEALTH EXHIBITION.

An International Health Exhibition is to be opened Paris in May of this year, and is to remain open ıtil the 15th September next. It will be held in the ılais des Arts Liberaux, Champs de Mars, and is ıder the patronage of the Minister of Commerce, e Minister of the Interior and of Public Works, ıd various Scientific Societies. The organisation is ıtrusted to a Commission composed of members presenting the State, the City of Paris, the departıents and towns, as well as the various societies and ırporations interested in questions of hygiene. The xhibition itself is to be divided into ten groups, as ıllows:—Class I. Hygiene of the House—This will ımprise buildings, soil, and sub-soil; lighting, arming, ventilating; water supply; kitchens; furiture. In this category will be comprised the special ygiene of hospitals, barracks, prisons, theatres, oncert and assembly rooms, refuges and shelters for he poor. Class II. The Health of Towns—Water upply; cleansing of public streets; disposal of refuse nd its treatment and utilisation; lighting of the treets, gas and electricity; disposal of the dead; ssistance in case of accidents, &c. Class III. Treatment of Infectious Diseases—Isolation and nethods of removing patients suffering from conageous diseases; vaccination; disinfection; hospitals; anitary legislation, &c. Class IV. Demography and Sanitary Statistics—Marriage, birth and death rates; causes of deaths; epidemics; comparative demography, &c. Class V. Sanitary Science—Laboratories for the study of the adulteration of food products; laboratories for researches into bacteriology, chemistry, and physiology, as applied to hygiene; health lectures, &c. Class VI. Hygiene of Infancy —Food, clothing, and training in early childhood; crèches; primary schools, &c. Class VII. Industrial and Professional Hygiene — The construction and sanitary conditions of workshops and factories; workmen's dwellings; accidents and their preventions; the physical and moral condition of workpeople; the special hygienic conditions of various professions; military and naval hygiene, &c. Class VIII. Food Products—Solids; liquids; the preservation of food and its preparation; mineral waters, &c. Class IX. The Hygiene of Clothing—Laundry work; sanitary clothing, &c. Class X. Physical Exercise—Gymnastics; fencing; massage; rational training, &c.

Obituary.

Sir Robert Hamilton, K.C.B.—Sir Robert George Crookshank Hamilton, who died at his residence in South Kensington on Monday, 22nd inst., aged 59, was for some years greatly interested in the success and development of the Examinations of the Society of Arts. From 1866 to 1879 he was joint Examiner for Book-keeping with Mr. John Ball, and sole Examiner from 1879 to 1882. It is not necessary to give here the particulars of Sir Robert Hamilton's distinguished public career, as these have been fully set forth in the daily newspapers.

General Notes.

Kioto Exhibition.—The fourth National Japanese Exhibition, from April to August, 1895, which was announced in the *Journal* last year (*see* vol. xlii. p. 858), as to be held at Kioto, in commemoration of the eleven hundredth anniversary of the foundation of the city. Information has been received from the Foreign-office, through the Science and Art Department, of the Association for Accommodation of Foreign Visitors, which has been formed with the following objects:—(1) To provide comfortable lodgings either in hotels or Japanese homes, and to furnish carriages and *jinrikishas* at reasonable prices; (2) to afford special convenience for the inspection of schools, factories, temples, and sites and remains of historic interest; (3) to introduce to Japanese specialists those who desire to investigate subjects of science, art, or manufacture; (4) to be a medium of business transaction between foreigners and Japanese, and to give special facilities for the purchase of articles; (5) to start a club for the reception and entertainment of strangers, as well as for the promotion of social intercourse between the representatives of all nations; (6) to secure reliable guides and Interpreters; and (7) in all other ways to assist strangers, so as to make their stay in the city comfortable, profitable, and interesting. Visitors wishing further particulars should apply to Taihin-Kyokwai, Yuraku-Kwan, Kioto, Japan.

Cider in France.—The production last year was 15,541,051 hectolitres of 22 gallons, which was above the average of the last ten years by 2,121,710 hectolitres, but below that of the previous year, which was exceptional and reached 31,609,000 hectolitres. Notwithstanding this diminution the harvest was considered generally good. The average yield of the ten years ending with 1893 was 13,419,000 hectolitres. The yield of wine in France last year was somewhat above the average of the past ten years, reaching 39,052,809 hectolitres, against a mean of 30,274,700 hectolitres. There was therefore a smaller import of foreign wines, 3,513,157 hectolitres, against 5,895,000 hectolitres in the previous year. The number of hectares under vines was only 1,766,841, a diminution of 26,000 hectares compared with the previous year. The yield was only 22 hectolitres per hectare, a decrease of 6 hectolitres as compared with 1893.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

MAY 1.—"Deviations of the Compass." By PROF. A. W. REINOLD, F.R.S. DR. W. ANDERSON, F.R.S., Vice-President of the Society, will preside.

MAY 8.—"The Extraction of the Rarer Metals from their Oxides." By PROFESSOR WILLIAM CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

MAY 15.—"Means for Mitigating the Fading of Pigments." By CAPTAIN W. DE W. ABNEY, C.B., F.R.S.

MAY 22.—"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. CHARLETON, A.R.S.M.

INDIAN SECTION.

Thursday Afternoons, at Half-past Four o'clock:—

MAY 23.—"Punjab Irrigation: Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 21.—"Commercial Education in Belgium." By PROFESSOR WILLIAM LAYTON. LORD REAY, G.C.S.I., G.C.I.E., will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

MAY 7.—"Recent Improvements in Designing, Colouring, and Manufacture of British Silk." By THOMAS WARDLE. H.R.H. THE PRINCESS MARY DUCHESS OF TECK will preside. [This meeting will be held at Four p.m.]

MAY 28.—"The Decoration of St. Paul's." By PROF. W. B. RICHMOND, A.R.A.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

JAMES DOUGLAS, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures.

LECTURE II.—APRIL 29.—*The Calcination of Ores and Chlorination of Gold and Silver.*—Almost entire replacement of hand by mechanical calcining furnaces in the western sections of the United States—Three types of mechanical calciners: I. Rake furnaces. II. Long drop shaft furnace. III. Cylinder furnaces—The Spence rake furnace—The O'Hara-Brown-Allen rake furnace—The Brown horse-shoe furnace—The Pierce turret furnace—The Stetefeldt shaft calciner—The White Howell revolving cylinder—The Bruckner cylinder—The Douglas cylinder—The Plattner process of gold chlorination in Grass Valley—The Mears modifications—Chlorination and filtration under pressure in Dakota—The Patera process as modified in the Russell process.

MEETINGS FOR THE ENSUING WEEK

MONDAY, APRIL 29 ... SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr James Douglas, "Recent American Methods and Appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." (Lecture II.)

Surveyors, 12, Great George-street, S.W., 8 p.m Adjourned Discussion on Paper by Mr. G Cadell, on "Forestry."

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.

Zoological, Regent's-park, N.W., 4 p.m. Annual Meeting.

TUESDAY, APRIL 30...Royal Institution, Albemarle-street, W., 3 p.m. Professor George Forbes, "Alternating and Interrupted Electric Currents." (Lecture II.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Royal United Service Institution, Whitehall, S.W., 8 p.m. The Hon. J. G. Ward, "New Zealand in 1895."

WEDNESDAY, MAY 1 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. A. W. Reinold, "Deviations of the Compass."

Royal Institution, Albemarle-street, W., 5 p.m. Annual Meeting.

Entomological, 11, Chandos-street, W., 8 p.m. 1. Mr. W. L. Distant, "A Probable Explanation of an Unverified Observation Relative to the Eamily *Fulgoridæ.*" 2. Mr. James J. Walker, "A Preliminary List of the Butterflies of Hong Kong, based on Observations and Captures made during the Winter and Spring months of 1892 and 1893."

Archæological Association, 32, Sackville-street, W., 4½ p.m. Annual Meeting.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Mr. A. V. Newton, "Notes suggested by the Examination System as Practised in the United States Patent-office." 2. Mr. G. G. M. Hardingham, "The Working of Austro-Hungarian Patents."

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, MAY 2...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. "The Distribution of Plants on the Southern Side of the Alps," by the late John Ball. With an introduction by Mr. W. T. Thiselton Dyer.

Chemical, Burlington-house, W., 8 p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. Phené, "The Social Influence of Art."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Liquefaction of Gases." (Lecture II.)

FRIDAY, MAY 3...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Veterinary-Captain Frederick Smith, "The Structure and Function of the Horse's Foot."

Geologists' Association, University College, W.C., 8 p.m.

Junior Engineering, Westminster Palace Hotel, S.W., 8 p.m. Messrs. Ernest King and Kenneth Gray, "The Warming of Buildings by Hot Water."

Philological, University College, W.C., 8 p.m. Annual Meeting.

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, MAY 4...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Arnold Dolmetsch, "English Music and Musical Instruments of the 16th, 17th, and 18th Centuries." (Lecture II.)

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FRIDAY, MAY 3, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Mr. James Douglas delivered the second lecture of his course on "Recent American Methods and Appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver," on Monday evening, April 29th.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, April 23, 1895; Prof. W. C. Roberts-Austen, C.B., F.R.S., in the chair.

The paper read was—

THE ART OF CASTING BRONZE IN JAPAN.

By W. Gowland, A.R.S.M., F.C.S., F.S.A.

Late of the Imperial Japanese Mint.

The art of casting bronze has been practised by almost all nations from very early times. In Europe, at a remote period, long before the dawn of history, we have numerous examples of the skill of primitive man as a founder of bronze. Weapons of defence and implements of the chase are the chief specimens of his earliest work; but later, when other wants arose, beyond the bare necessaries for his existence, we find, together with these, objects for personal adornment and domestic or ceremonial uses.

In Asia, the earliest practice of the art is shrouded in the mists of extreme antiquity. Certain bronze figures from Chaldæa are attributed to a period not later than 2,000 B.C., and although of very archaic form and rude execution, indicate that the casting of bronze must have been followed in that country, even for many centuries before that remote date.

In Japan, the founders' art has a much less antiquity; it does not extend back to these distant periods; in fact, no remains of any metal castings—even of weapons of defence—have been found there, approaching in age even those of the early bronze period in Europe.

The Japanese do not appear to have migrated to the islands they now occupy earlier than perhaps seven or eight centuries B.C., and the aborigines whom they found there were totally unacquainted with the use of metals. Hence all objects of metal of the earliest times which have been discovered are Japanese, and are not older than that time.

The evidence afforded by tumuli and dolmens, and the remains found in them of the early history and civilisation of the Japanese, demonstrates clearly that, in prehistoric times there were two periods, which are more or less clearly defined by the progress which they made in the art of metallurgy, viz., a bronze and an iron age. The bronze age begins with the immigration of the race, and terminates about the second century B.C. The iron age then commences, and extends to the present time.

It is worthy of note here that the bronze age, and the first period of the iron age, are also characterised by two distinct forms of sepulchral monuments, the former by barrows, or simple mounds of earth, and the latter by megalithic dolmens and highly specialised forms of chambered tumuli. There is no evidence whatever of a copper age preceding that of bronze, but contemporaneous with the early iron age, and up to the 6th or 7th centuries A.C., we find copper in more extensive use than bronze. Iron swords, trappings, and bits for horses, decorated with thin sheets of copper, coated with gold, are found in abundance, whilst objects of bronze are rare.

The Bronze Age.

The castings which represent the early bronze age in Japan consist solely of swords and arrowheads, the wants of the people then being evidently few and simple; and although objects for personal adornment were in use they were made exclusively of steatite, jasper, quartz, or other stones. The swords are found in barrows or merely buried in the ground, and never along with objects of iron; the arrowheads, on the other hand, occasionally occur also in dolmens, associated with iron swords, and thus connect the bronze with the iron age.

These bronze swords are undoubtedly the most ancient castings in Japan. They are simple two-edged weapons, resembling in form the short sword of the ancient Greeks. In some examples the blade is cast in one piece with the hilt, but in others with a tang, to which a hilt was subsequently attached. The mould was of stone, and was made in two pieces. Illustrations of a mould and sword are exhibited. This is the oldest mould for casting bronze in existence in Japan. It was found by a Japanese archæologist in use by some farmers as a hone for sharpening their sickles.

(I may say here that on my visit to Soül, the capital of Korea, I found stone moulds in use for casting simple silver articles, the stone being an indurated tuff.)

I was unable to obtain any fragments or even scrapings of these swords for analysis as there are but few existing, and they are highly prized, but a fragment of an arrowhead which I examined, consisted of copper and tin, and did not contain lead as an essential constituent, and the swords are probably of the same alloy.

Early Iron Age (from about 2nd Century B.C. to about 6th Century A.D.).

In my explorations and studies of the remains which occur in the ancient Japanese dolmens and chambered tumuli, I have always observed a marked scarcity of castings of bronze. Circular mirrors, small bells, and arrowheads, occasionally are found, but they form an insignificant part of the contents of a dolmen, the chief objects being swords, arrow and spearheads, horse furniture, and other articles of iron, many of which are plated with thin sheets of copper, coated generally with gold, and sometimes with silver. The bells, which are of the form called by the Japanese "suzu," are simple hollow spheres with a slit cut in the lower half, and contain a loose piece of metal or a small round pebble to serve the purpose of a tongue. They rarely occur singly, but are usually cast in groups on the edges of a flat support furnished with a hole and tang for attachment probably to a staff, or in some cases to the trappings of a horse; they appear also to have been used as ornamental appendages to garments and the hilts of swords.

Several plates illustrating their forms and use are exhibited. The mirrors are the earliest examples of art castings found in Japa[n]. Many are decorated with very elabora[te] designs, and the excellence displayed in t[he] execution of all denotes a very advanced sta[ge] in the art of moulding and casting. Some a[re] undoubtedly Chinese, and others are probab[ly] native copies of the Chinese designs, but not [a] few are of true Japanese workmanship. A[n] engraving of a mirror bearing a date—t[he] dynastic title Wangmang—9-23 A.D., is e[x]hibited.

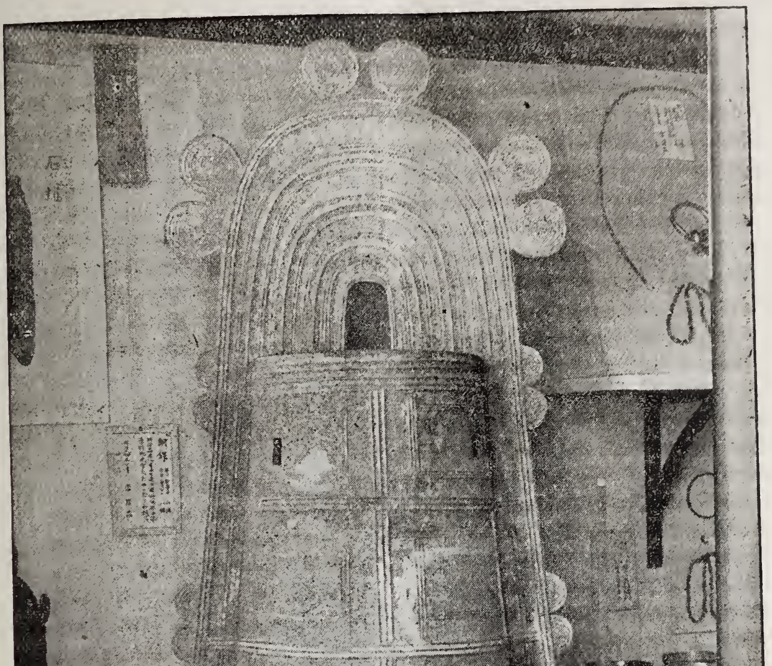
The five mirrors from the province of Hi[go] in Kijushu, shown in the lantern slide, a[re] said by Japanese archæologists to be [of] Chinese origin. It is impossible to assi[gn] an exact date to the older specimens; t[he] curator of the Imperial Museum, Tokyo, attr[i]butes the Chinese forms to the period Ha[n] (25-220 A.D.), and I am inclined to agree wi[th] him in this attribution. Three specime[ns] (Gowland collection, British Museum) whic[h] I obtained from the province of Yamato we[re] associated with "magatama" and other ve[ry] ancient stone ornaments, and are probabl[y] not later than the above period. These a[re] almost certainly Japanese. The simple ge[o]metric designs with which they are decorate[d] bear no relation to the more elaborate patter[ns] seen on Chinese forms.

The largest castings of the early iron ag[e] are curious bell-shaped objects (Fig. 1), whic[h] are of special interest from their form an[d] archaic ornament. It has been conjecture[d] that they are temple bells, but they present n[o] points of resemblance to these or to an[y] instrument or object connected with the cere[]monies or observances of Buddhism, and are[,] in fact, of earlier date than the introduction [of] that religion into the country. Moreover, non[e] show any signs of having been hung. A con[]siderable number have been found — alway[s] buried in the ground — chiefly in Yamato[,] Kawachi, Totomi, and the neighbouring pro[]vinces.

As early as 669 A.D., the discovery of one i[s] recorded, and this was even then regarded a[s] being of such a great antiquity that it wa[s] presented to the Emperor. The designs wit[h] which they are ornamented—the simple geo[]metric line patterns common to many primi[]tive races—are also evidences of their grea[t] age. They vary in dimensions, from 1 or [2] inches to $5\frac{1}{2}$ feet in height, those measurin[g] 1 feet 6 inches to 3 feet being most common[,] and all are of extreme thinness compared wit[h] their size. Their exact use is still a subject o[f] dispute among archæologists.

'he example shown in the illustration Fig. 1 ısures 4 feet 6 inches in height and 1 foot ıches in diameter at the base, and does not exceed $\frac{3}{16}$ inch in thickness. It is an excellent casting, and must have been cast in a heated mould.

FIG. 1.



EARLY IRON CASTING.

7TH AND 8TH CENTURIES A.C.

Two events of marked importance in apanese annals, on account of their influence n the development of the arts and culture, ccurred during this period. Buddhism, hich had been introduced about 552 A.D., had been adopted as the religion of the country through the energy and enthusiasm of Prince Shōtoku Taishi (593-621 A.D.), and a fixed capital and Court had, for the first time in Japanese history, been established at Nara (709 A.D.). These two centuries form a

brilliant epoch in the history of the art of bronze founding, as in that of the sister arts of painting and sculpture. Numerous temples—some on a scale of great magnificence—were erected for the services of the new religion, and the skill of both native and foreign workers in bronze was specially enlisted for their decoration, as well as for the production of statues of the divinities of Buddhism, and of vessels for the ceremonies of its ritual.

Stimulated and supported by the priesthood in their efforts to produce objects worthy of the services of the church, the bronze founders achieved results in those early times which have not since been surpassed. Unfortunately, many of their works have been destroyed by conflagrations, and in the frequent spoliation of the temples during civil wars, but a few have been preserved, which are masterpieces of the art of the modeller and founder.

Many tales record the enthusiasm with which the founders of the time were supported by their patrons, and of the stubborn manner in which, after many repeated failures, they overcame the difficulties which beset them. The Empress Kōken (749-758) herself is said to have aided the founders in stirring the molten metal for a statue of a Buddhist saint, which was only completed after six unsuccessful attempts. The development of bronze founding, and the encouragement of its artists, during this period was entirely due to Buddhism, and even for many centuries later the chief works of the art founders were executed for the adornment of its shrines. The survival of most of the older bronzes is also solely due to the care with which they have been preserved in temples and monasteries by the priests of that religion.

Japanese records and traditions relating to the works of art of this epoch, whether of the painter, sculptor, or founder, invariably speak of the help afforded in their production by Korean or Chinese artists; and not a few of the ancient examples which survive are even attributed solely to them.

It is very difficult to determine how far these traditions relating to Korean artists are trustworthy, as no traces of similar works have been found in Korea itself; yet they all present such a close agreement on the point, that we are almost compelled to acknowledge that if not perhaps true in the details they give of individual artists, yet, broadly speaking, they may be based on facts; and that the Japanese owe to Koreans, or probably rather to Chinese who may have come through Korea, the great advances which they made in the cas of bronze.

Besides the influence which the neighb ing countries—China and Korea—had on *technique* and motives of the Japanese brc founder, we have also abundant evidence the influence of the art of more distant regi Amongst the treasures of the temple Hor (near Nara, Yamato) are several Indian stat in bronze of Buddhist saints and deities, a curious ewer, which are said to have beer the possession of the temple from the d of its erection in the early part of the century. The characteristic pose of figures, the modelling of their features their jewelled headdresses, have been quently copied, with more or less modificati and can be distinctly traced in many anci Japanese statues, as well as in some of cc paratively modern times. The ewer, a bro casting of graceful form, is decorated w figures of winged horses of the form of Pegasus of the ancients. According to Lo perier (Gonse: "L'Art Japonais") it is doubtedly Sassanian, and of earlier date tl the 7th century. An illustration is given o in the "Handbook" of the ancient articles the temple Horyuji, which will be found on table. This ewer is of special interest, as, the kindness of my friend, Mr. Alfred Cocl am able to show you a bronze incense burn which has been modelled probably during the l century from one of the pegasi with which i ornamented. Other bronzes of foreign ori are also to be seen in the treasure houses several of the ancient temples in Yamato.

During this epoch, especially that part it which has been styled the "Nara perio (the seven reigns during which Nara was capital, 709-784), the great development bronze founding was not the only adva made in the working of metals; but art of incised and *repoussé* work in gilt copp which had been practised during the ea iron age, was brought to a stage of p fection beyond which it has never passed. specimen of this work will be found on table, and others are illustrated in the colou plates near it.

The examples contained in the followi list I have selected as representative spe mens of the art of bronze founding duri this period (7th and 8th centuries).

Date 690 to 702 A.D. Three bronze figu representing a Buddhist Trinity—Amitâbl Kwanyin, and Mahâsthâma—that of Amitâb

[bei]ng about 9 feet in height. They resemble [the] Indian examples at Horyuji in being origin[all]y gilt, but the bronze of which they consist [is] of a different composition, not containing [zin]c as an essential constituent.

[D]ate 690 to 702 A.D. A coloured seated [im]age of Yakushi (the healing divinity) about [10 f]eet high, with two attendant deities cast of [c]opper-tin-lead bronze.

[A]ll the above are in the temple Yakushiji in [Na]ra. Illustrations of the latter group are [giv]en in two plates from the "Pictorial Arts [of] Japan," by Prof. W. Anderson, which are [on] the table.

[Date] 705 A.D. A spherical box of gilt bronze [be]aring this date, which was found in a stone [sa]rcophagus at Ten-ō-ji, near Ozaka, is inter[es]ting, as it is probably the oldest dated piece [of] Japanese metal work in the country.

Date 708 A.D. Bronze coins, "Wadō-zeni," [th]e earliest coinage in Japan of which there is [an]y record. According to Japanese histories [co]pper is said to have been discovered in the [co]untry only in 698 A.D., but the accuracy of [th]is statement for many reasons is open to [do]ubt, and the discovery chronicled doubtless [on]ly relates to the finding of deposits of ore [of] more than usual extent and richness. The [is]sue of this coinage, which was cast from [co]pper from these deposits, was regarded as [a]n event of great national importance, and to [co]mmemorate it, the "nen-go" or name of [th]e period by which the series of years are [d]istinguished in Japanese chronology, was [a]ltered to "Wa-dō," which signifies Japanese [c]opper. Besides these, there were three other [d]istinct coinages during this century.

Date 732. The great bronze bell of the [te]mple Tōdaiji, in Nara. Its approximate [d]imensions are—Height, 13 feet; diameter, [9] feet; thickness, 8 to 10 inches. Its weight [c]annot be easily determined as its thickness [i]s variable, but at the lowest estimate cannot [b]e much less than 40 tons.

Date 749, A.D. Colossal image of Rochana [o]r Vairotchana, in the temple of Todaigi, [c]ommonly known as the Nara Daibutsu.

This is the largest bronze figure in the [c]ountry. It has not, however, been cast in [o]ne piece, but is constructed chiefly of [n]umerous pieces of comparatively small size. [S]ome of the lower portions have been cast by [b]uilding up the mould on the parts already [f]inished, but the greater part of the image [c]onsists of separate castings which have been [u]nited by running in an alloy containing large [p]roportions of tin and lead between their edges.

The following dimensions are those given on a wood engraving of the image—one of which is exhibited—sold by the priests of the temple, and may be considered as only approximately accurate:—Height, 53·2 feet; breadth of face, 9·4 feet; length of eye, 3·9 feet; thickness variable, 3 to 12 inches.

The figure is seated on a huge lotus flower with 56 external petals, each of which measures 10 feet 6 inches × 6 feet, and appears to be a single casting. Twice it has been partially destroyed by conflagrations and once by an earthquake. The present head, cast in the 16th century, is extremely ugly, destitute of any trace of the grace and refined expression of the earlier statues, and not at all in harmony with the ancient parts of the figure.

The authorities of the temple state that the image is composed of "shakudo" (a copper alloy containing gold); they also give the weights of the copper, tin, gold, and mercury, which were used in casting it, and these statements have been repeated by many writers. They are altogether without any foundation in fact. I have had many opportunities of examining it, and although I never succeeded in getting a portion for analysis, yet from the streak, hardness, and colour of the metal, it is undoubtedly a variety of "karakane" (a copper-tin-lead alloy), and the gold and mercury said to have been used in its manufacture were simply employed for gilding its surface, and not as constituents of the alloy of which it is cast. Four hundred and fifty tons of metal are said to have been used in its construction. If its average thickness is as much as 7 inches, and it is probably less, its weight must be less than 300 tons. The two following objects are examples of the smaller works of the period.

Date 749 A.D. Bronze bell, with curious ornamental tongue, now in the temple Tō-dai-ji (Nara). Dated 2nd day, 5th month, 1st year Tem-byō Shō-hō. This is of importance, as it is another of the earliest bronzes which bears a date, but, unfortunately, no artist's name.

Date 8th century. Lantern of bronze and incised gilt copper in the courtyard of the same temple. Its eight sides are decorated with Buddhist figures, conventional representations of hares and other animals, and fine arabesques in open work. A photograph of this lantern is exhibited.

A gong-shaped bell, suspended between two well-modelled dragons, belonging to the temple Kō-buku-ji, in Nara, is attributed to this period.

A Buddhist image from the collection of Monsieur Bing, of Paris, of the same period.

From the Beginning of the 9th to the End of the 12th Century.

Near the close of the preceding epoch the Court was removed to the city of Kyōto, which from that time (794 A.D.) up to 1868 continued to be the imperial capital. This removal of the Court was a severe blow to the art life of the ancient city; and the works and traditions of its old bronze founders soon appear to have been forgotten or neglected in the new metropolis.

From the beginning of the 9th until near the end of the 12th century, a space of nearly four hundred years, we have a period of stagnation, if not of decadence, in all art, yet, strange to say, it embraces the golden age of literature, during which the famous classical romances were written. Its first half, as shown by these romances, was marked by effeminacy; during its second, the country was plunged in civil war. The romances give us but little information of the individual and art life of the people, and the pages of its histories are solely devoted to records of the jealousies and feuds of the great families of Fujiwara, Taira, and Minamoto.

Until near its termination, we have no record of the erection of any temple of note, or of the execution of any great art work; and I have been unable to find any examples of the art of the bronze founder during the entire period, excepting two insignificant boxes for holding seals (dated respectively 998 and 1098 A.D.), and nine distinct coinages of bronze money (from 810 to 958 A.D.). After this last date even the coinage of money appears to cease, and is not resumed until 1457 A.D.—five hundred years afterwards.

13th Century.

During the last years of the 12th century, when peace was established throughout the country by the victories of Yoritomo, there are the first signs of a revival of the old art of the Nara period. From 1190 A.D. up to the date of his death (1198 A.D.), this remarkable warrior devoted all his energies to the cultivation and advancement of the arts of peace. Stimulated by his example and enthusiasm, the artistic spirit of the people was aroused from its dormant condition, and for nearly a hundred years we have a notable period of renaissance in art. A period chiefly remarkable in the history of bronze for the casting of that magnificent masterpiece, the colossal image of Amitâbha, usually called the Daibutsu of Kamakura. This image, on[e] o[f] the finest examples of bronze founding, ca[n]not be adequately described by any word p[aint]ing; it must be actually seen in the mid[st] of its grove of conifers and evergreens to [ap]preciate fully its grandeur and beauty, [i]ts soberness of design, and noble expressio[n] o[f] majesty and repose. It stands alone [a]nd incomparable among all the *chefs d'œuvre* of Japanese bronze founders.

Although slightly smaller than the g[reat] Buddha of Nara, it far excels it in arti[stic] execution. Like it, it has been cast in s[eg]ments, but these have been "burned togeth[er]" with bronze of similar composition to that of [th]e image itself, the exterior of the joints hav[ing] been subsequently finished by chiselling.

Japanese histories relate that it was c[ast] about the middle of the 13th century (beg[un] 1252 A.D.) by Ono Goroyemon, one of the f[irst] bronze founders whose name is recorded. [Its] dimensions, taken from a woodcut sold [to] pilgrims who visit its shrine, are as follows:—Height, 49 feet 7 inches; length of fa[ce], 8 feet 5 inches; breadth from knee to kn[ee], 35 feet 8 inches.

The measurements of both this and t[he] Nara Buddha, however, require revision; t[he] height in both cases are, I think, exaggerat[ed] and should have 6 or 7 feet deducted fr[om] them. Its thickness is variable, ranging fr[om] $1\frac{1}{2}$ inch to 3 or 4 inches, or even more in so[me] of the castings, and its weight will not pr[o]bably exceed 150 tons.

Other bronze images of the divinities of t[he] Buddhist hierarchy, of less colossal propo[r]tions and of varying degrees of excellenc[e] were made for the temples of Yamato a[nd] Kyōto, one of the chief groups being a Trini[ty] for the ancient monastery Horyuji. Sever[al] bells were also cast, one at Kamakura bein[g] worthy of note, as the record given of it ind[i]cates the source of the metal from which the[y] were occasionally made. It is said tha[t] 300,000 copper coins, which had been co[l]lected by the priests of the temple, wer[e] melted down for casting it, and the meta[l] being insufficient, the casting was a failure[;] 30,000 more coins were then collected fo[r] addition to the defective bell, when it wa[s] remelted. It is also recorded that coppe[r] coins were similarly melted up for casting Buddhist images and ornamental utensils[;] hence it would appear that it was not then deemed necessary to use a different alloy for bells and art castings than for coins.

14th and 15th Centuries.

During the 14th and 15th centuries we have again a period of decadence, with the exception of two short brilliant intervals, the first during the supremacy of the Ashikaga Shōgun, Yoshimitsu (1368-93 A.D.), and the second during that of Ashikaga Yoshimasa (1449-71 A.D.) For the greater part of this period, the country was again in a state of unrest and intestine conflict, and the arts of peace found but little encouragement, excepting so far as they contributed to the needs of war.

Workers in iron are brilliantly represented by one of the greatest of the famous forgers of sword blades, Masamune, and by several distinguished armourers and smiths of the renowned Mio-chin family; but the bronze founder was not in request. His chief work during these two centuries was a colossal figure of the Buddha Vāirōtchana, cast during the time of Yoshimasa for the temple at Hase (Kamakura). I have not seen this image, but it is said to be an admirable casting and to measure 30 feet 6 inches in height.

Two bronzes which were exhibited at Nara in 1888 represent the smaller castings of the period, one an incense burner which was presented by the hero Kusunoki Masa-shige (first half of the 14th century) to the temple at Hase (Yamato), and a war bell also given by him to the Emperor Godaigo.

16th Century.

In the last decade of this century, after another period of civil war, the patron of art and culture is again a famous warrior, Hideyoshi (often known as Taiko Sama). Although then engaged in war with Korea the closing years of his life were devoted to peaceful pursuits at home, and in imitation of Yoritomo at Kamakura, he erected a huge Buddha and a temple to contain it at Kyōto. On the destruction of the image, which was of wood, by an earthquake only eight years after its erection, he contemplated replacing it by one of bronze, but the execution of this was delayed by his death (1598 A.D.), and was only accomplished by his son and widow sixteen years afterwards.

No large bronzes of importance appear to have been cast during this century. Two specimens of the smaller bronzes are exhibited, one a figure of Yakushi (the Healing Divinity), belonging to my friend, Mr. Alfred Cock, in which the deity is represented holding a crystal ball, an emblem of purity, in his left hand. It bears the names of its dedicators to the temple, and the date 1569.

The other is a bell of the form known as "waniguchi," crowned with the figure of a tortoise encircled by the coils of a snake, kindly lent by my friend, Mr. Harding Smith. It also bears the name of its dedicator and the date 1593.

Several specimens of dedicatory bronzes of this time are to be found not only in Buddhist temples but also in Shinto shrines. Two examples of the latter may be mentioned, although they are notable rather for the fame of their donors than for their artistic excellence; a gigantic bell of similar form to the last offered by Hideyoshi to the Shinto shrine at Nachi (Kyushu), and a large mirror (3 feet diameter) dedicated to the Tenjin Miya at Kitano (Kyōto) by Kato Kiyomasa, one of Hideyoshi's noted generals in the Korean campaign.

I cannot omit to show you on the screen a magnificent bronze in the famous Cernuschi collection in Paris, which is attributed to this period. It is supported on a pedestal of rich open work, and is decorated with gourds and a heraldic representation of the leaf and flowers of the *Paulownia imperialis*.

Another splendid example of "cera perduta" casting of this period is a group of egrets, standing upon an inverted lotus leaf, which has been kindly lent by my friend, Mr. Alfred Cock.

17th Century, and First Half of the 18th.

In 1603, Tokugawa Iyeyasu, a man of remarkable ability, both as a warrior and a statesman, succeeded to the Shōgunate, and, by his wisdom and foresight, established on firm foundations the Japanese system of feudalism, which, under the rule of his successors, gave absolute peace to the country for more than two and a half centuries, and resulted in an advance and development of the arts unparalleled in any previous age.

During the supremacy of these Tokugawa Shōguns, the painter, the lacquerer, the potter, and the founder were encouraged and stimulated as they had never been before to bring their respective arts to the highest point of excellence; and it is in no small degree owing to the works which they produced during this period, that Japan owes the prominent position which she now so deservedly occupies in the world of art.

The first great works of the bronze founders

of the 17th century were a colossal figure of the Buddhist divinity Rochana in Kyōto, to replace the wooden image destroyed by an earthquake in the previous century, and a huge bell for its temple.

The figure is said to have been 58½ feet high, and from the records regarding the first attempt to cast it, it would appear that it was cast *in situ*, and in segments, the mould being built up on the parts already finished. It would thus, when completed, have been practically a single piece of metal. This attempt was a failure, as when casting the lower part of the head, the wooden scaffolding was set on fire by the operations, and the image partly melted. It was successfully completed in 1614, but only 48 years afterwards, like its wooden predecessor, it was destroyed by an earthquake. According to official records, its fragments were melted in 1668-83, and cast into the bronze coins (Kwan-ei-tsu-ho) then current.*

This record is interesting, as it affords another proof that the alloy used by bronze founders did not differ much in composition, if at all from that in use at the time in the mints for coins. I have analysed these coins with the following results. Individual coins differed considerably from one another in composition, the per-centage of copper present varying from 69·8 to 86·8, a variation not greater, however, than might be expected from the nature of the alloy, and the mode in which it was cast. Hence, in order to ascertain their average composition, 7,600 pieces were melted together, and the resulting metal was analysed, and found to consist of—

	Per cent.
Copper	77·30
Tin	4·32
Lead	15·33
Arsenic	1·14
Antimony	0·31
Zinc	nil
Iron	1·01
Silver	0·06
Sulphur	0·52
Gold	trace
	99·99

We may hence, not unreasonably conclude that this represents, approximately, the composition of the alloy which was used for casting the colossal Buddha.

The bell is the largest in Japan. Its dimensions are approximately—Height, 14 feet; external diameter at the mouth, 9 feet; thickness at the rim 10¾ inches. section these bells differ from European fo in having the rim thickened internally so tl their mouths are constricted. (Fig. 2.) A

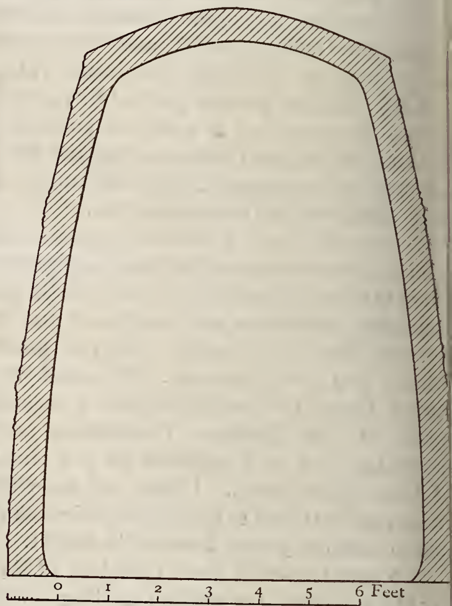


FIG. 2.—SECTION OF TEMPLE BELL.

And it is this constriction which causes th gentle rising and falling tones which charac terise the boom of all Japanese bells. It i hardly necessary to mention that these bell are not swung, neither are they furnished wit tongues, but are rung by striking the outsid by means of a beam of wood suspended fron the bell tower and swung like a battering ram The point struck is a low boss, which some times has the form of a lotus flower.

Two other similar bells were cast during th first half of this century (17th), details of whicl are given in the following Table :—

TABLE I.—APPROXIMATE DIMENSIONS, &c., OI FOUR OF THE LARGEST TEMPLE BELLS IN JAPAN

Date.	Name of Temple.	Height.	External diameter at the mouth.	Thickness of rim.	Approximate weight.
		ft. in.	ft. in.	in.	tons.
8th century.	Tōdai-ji, Nara.	12 9	8 10	10	49
1603 A.D.	Dai Butsu, Kyōto.	14 0	9 0	10¾	56
1633 A.D.	Chion-in, Kyōto.	10 10	9 0	9½	43*
1623-49 A.D.	Zō-jō-ji, Tōkyō.	12 0	—	—	—

* There is another record of the conversion of Buddhist statues into coins in 1450-70.

* The weight of this bell is often erroneously given by writers as 74 tons.

The exact average thickness of these bells cannot be ascertained without special measurements, which are not permitted, but it cannot exceed 8 inches, the thickness I have assumed for the above calculations, and may possibly be somewhat less. The casting of a large

FIG. 3.

BRONZE TOMB OF IYEYASU. DATE, 1617 A.D.

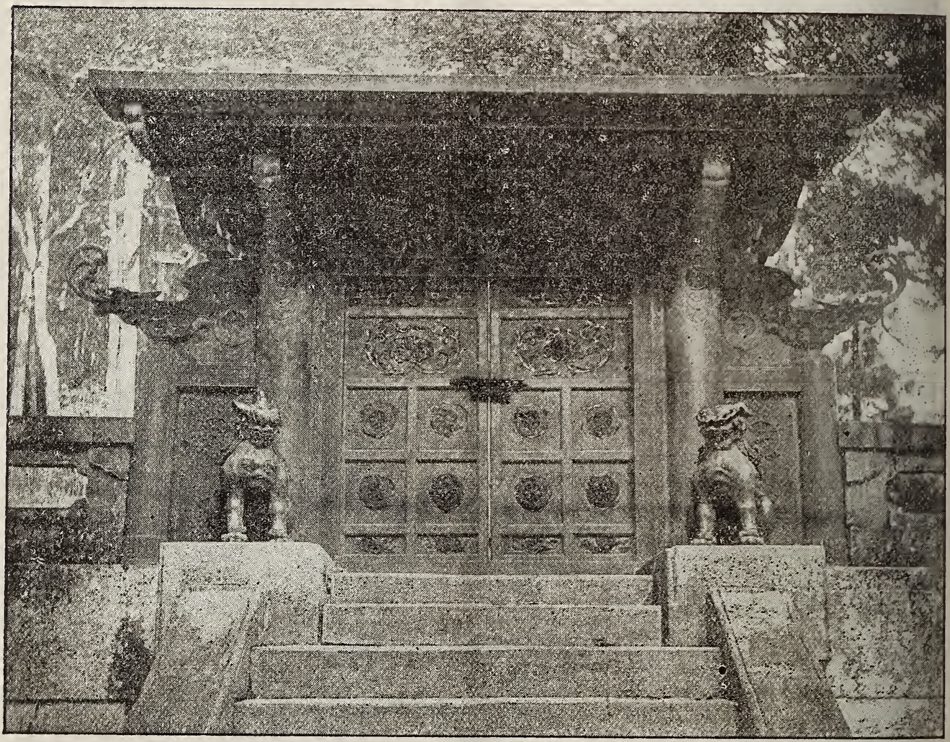
bell in old times in Japan was an important event, and was accompanied by religious ceremonies and popular rejoicings. On the day appointed for running the metal into the mould a grand festival was held at the temple in the grounds of which the founding operations were performed, and people of all ranks came from far and near with contributions,

many with offerings of mirrors, hair-pins, and metal ornaments, to be added to the bronze in the furnaces. On one occasion, that of the founding of the great bell of Zō-jō-ji, the Shōgun himself (Iye-mitsu) was not only present, but took part in the direction of the operations. In succeeding years the day was not forgotten, but its anniversary was celebrated by temple feasts.

The fame and repute of this "golden" period in the bronze founder's art does not however rest on the above castings, which are chiefly remarkable for their size and weigh[t] but on those now to be described, many [of] which are masterpieces of design, modelling and technical skill.

The oldest of these are the bronzes cast fo[r] the mortuary chapels, and tombs of the earl[y] Tokugawa Shoguns and members of thei[r] families. At the famous mausoleum at Nikk[o] there are some grand examples, one of th[e] most notable being the tomb of Iyeyasu (th[e] first Tokugawa Shōgun, died 1604 A.D.), a fin[e] casting in bronze, with bronze gates, dis

Fig. 4.



Bronze Gates of the Tomb of Iyeyasu.

tinguished by impressive simplicity and chasteness of design. (Fig. 3.) In front of the tomb are the three ceremonial ornaments (Sangusoku) of the Buddhist altar, viz. :—A vase, incense burner, and candlestick all of the severe style of the period.

The gates (Fig. 4) are splendid examples of bronze founding. Almost their whole surface is covered with delicate diaper and floral patterns, upon which ground the bolder ornamentation is moulded in relief. These consist of representations of the "chakra," or Buddhist wheel of the law, and floral designs, most of which are coated with gold. In front are the two fabulous animals (Koma-inu and Ama-inu) supposed to represent lions.

The tomb of Iyemitsu (third Tokugawa Shōgun, died 1649 A.D.) closely resembles that of Iyeyasu in form, but the reliefs on its bronze gates are simply Sanscrit characters in medallions. These tombs are situated in a grove behind the chapels and oratory, and their simplicity presents a striking contrast to the magnificence of these edifices, which are the most richly decorated shrines in the world. It is said that their plain and simple design is

tended as a concrete expression of the Buddhist aphorism that "at death there is an end all magnificence."

Numerous large standard lanterns (tōrō) of bronze (Fig. 5), contributed by the territorial nobles, who vied with one another in thus

Fig. 5.

Bronze Lanterns at Nikkō. Date, 17th Century.

doing honour to their departed chiefs, line the courtyards of the shrines. Many hundreds of these "tōrō," which were favourite votive offerings of the wealthy both to Buddhist temples and Shinto shrines, were cast during this period of revival in bronze founding. They adorn the approaches and grounds of every temple of note in the

country, those of Zō-jō-ji (Tōkyō) alone number more than 200.*

Each group or pair differs from any other, yet in outline and decoration all are in harmony; and if no other examples of bronze founding were in existence, the gracefulness of form and fertility of design which characterises all would alone mark their modellers and founders as artists of the first rank. It will be noticed that both of these in the illustration, although of the same general form, differ entirely in decoration.

The mausolea of other Tokugawa Shōguns also afford some fine examples of the bronze founders' art, notably the tombs of Iye-tsuna (1650-80), and Tsunayoshi (1681-1708), at Uyeno (Tōkyō), and of Iye-nobu (1709-12), at Shiba (Tōkyō). They are of similar form to those at Nikkō, differing from them chiefly in the more elaborate decoration of their gates. Finely-modelled dragons, and the armorial badge of the Tokugawas, ornament the gates of Iye-nobu's tomb, whilst in the tomb of Tsunayoshi—who was a noted patron of art—there is still a further departure from the simple style of earlier times, the symbolical combinations of the fabulous unicorn (Kirin) and pine tree, the phœnix (Hōō) and paulownia, and of the pine, bamboo, and plum being perhaps almost too lavishly employed.

Another important bronze at Nikkō, representative of the period, is a bronze column (1643 A.D.), termed sō-rin-tō, 42 feet in height, a form of the Indian "stupa," as introduced into Japan through China. Before removal to its present site it stood near the tomb of Iyeyasu, and was doubtless erected their in accordance with the Chinese superstitious beliefs in the efficacy of such structures in warding off evil influences, and ensuring the protection of heaven. Besides these, four huge lotus petals, for the base of the image of the Daibutsu at Kamakura, were cast at the beginning of the 18th century (1717). A small bronze of the 17th century I am enabled to show you through the kindness of Mr. W. Cleverly Alexander; it is an incense-burner, in the form of two rats, by Meiho. Also a candlestick for the Buddhist altar, decorated with a dragon coiled round its stem, from the collection of Mr. Alfred Cock. Two other candlesticks of the 17th century, or probably earlier, have been kindly lent by Mr. E. W. Hennell.

* Presented to the Shōguns Iyetsugu (1716) and Iye-shige 1762) by the territorial nobility.

From the Middle of the 18th Centur up to the Present Time.

Hitherto the skill of the bronze founders ha been chiefly exerted in the production colossal images and other huge castings f the temples of Buddha, and in giving a seve beauty to the forms and ornaments of utensi and implements for ceremonial purposes; b during this period, with the continuation peace, their art found a wider range in th designing of objects for secular use, for th decoration of the home and the every da needs of life.

Shortly before, the okimono, or ornament, thing of no practical utility, but only of di play, had been introduced, and this speciall opened up to the artist a rich and unlimite field for the exercise of his ingenuity and ski in the art of ornament and design. The vas too, formerly used only as a ceremonial vess of the Buddhist altar, now became a necessar object for the adornment of private life, and i its form and decoration the artist was no longe hampered by the old traditions and rules of th church. The founders of this period hence ar not chiefly notable, as in earlier times, for th works destined for the services of Buddhis or the embellishment of its shrines, althoug many remarkable castings were made, princi pally standard lanterns, dedicated as votiv offerings to temples and monasteries, an torii, or gateways of Shintō shrines, but ow their world-wide fame to the skill and fertilit of design exhibited in the objects above men tioned for household use, many of which ar masterpieces of form and ornament. Th following characteristic examples of Buddhis art cannot, however, be omitted from m account of this period:—

1736 A.D. A fine image of Sakya-muni, i the grounds of Zōjōji (Tōkyō).

1765 A.D. A colossal figure of Kwanyir 9-10 feet high, near the post town of Futa gawa on the Tōkaidō.

1778 A.D. An image of Sakya-muni (7- feet high ?), in the court-yard of Jō-shin-j Tōkyō.

End of 18th century. An image of Amitâbha formerly at Meguro near Tōkyō, now in th Cernuschi collection (Paris). Height from th base of the lotus flower to the top of the nimbu 14 feet 9 inches.

A figure of Amitâbha seated on a lotu flower (date 1772), lent by Mr. Alfred Cock, i an excellent example of the Buddhist art of th period.

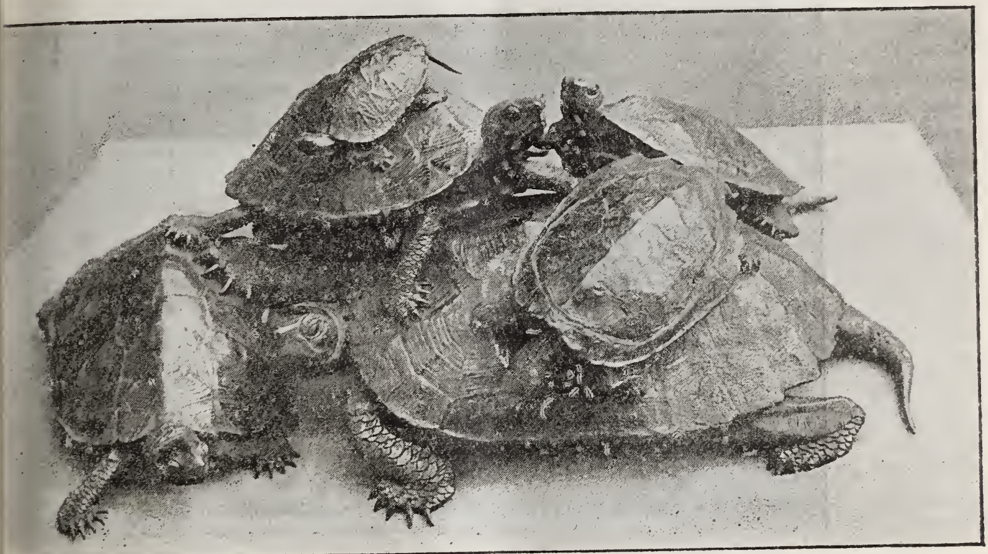
The period is also marked by an important ıturalistic monument in the schools of both ctorial and glyptic art.

They had up to this time followed the older en in basing their designs on the traditions Buddhism and the forms and motives of ıinese and occasionally of Indian art, but ›w they began to break away from the tram-els by which they were bound to these old ›nventional forms and motives, and to go to ıture for their inspirations and models.

It should, however, be remembered that much ; the works, especially of Chinese artists, ere admired, mere slavish copies were never r rarely made of them, thus in the bronzes ven of the early days, the figures of Buddhist divinities, there is a serenity of expression and graceful arrangement of drapery which we look for in vain in the masterpieces of Chinese art. Nearly contemporaneous with the establishment of the Shijo-rui — the school of naturalistic painting—in Kyōto, by the famous painter Ōkyo, we find the art founders adopting these new motives and new modes of representing the old. Stiff geometric designs give place to those based on natural forms, and even in representations of the mythical dragon we see, as has been pointed out by Prof. Anderson, "distinct evidences of direct study of snake form."

Studies of natural objects, of plant and animal life, were now made, the designs of the

FIG. 6.



BRONZE GROUP OF TORTOISES BY SEIMIN.

ıaturalistic painters were followed, and an mpulse was given to the art of bronze founding greater than had been known since the Nara period.

For a little more than three-quarters of a century we have another golden age in its ıistory, during which a succession of brilliant ırtists, distinguished by marvellous technical skill and originality of design, worthily maintained the best traditions of the founders' art, and Japan attained a position in cera perduta casting which she had never reached before.

Two men, Seimin and Toün, stand out prominently during the closing years of last century and the first quarter of the present. Others, among whom should be mentioned Harutoshi, Kunihisa, Kamejo, Teijo, Taüchi, approach these great masters in skill, even occasionally proving their equals. The work of these famous artists is well represented by the specimens on the table, the most important of which are from the collections of my friends, Mr. Alfred Cock, Mr. Mills, Mr. Alfred Parsons, and Mr. J. M. Swan, and by Fig. 6, a group of tortoises from the collection of Mr. J. M. Swan, and Fig. 7, a brazier from the collection of Mr. Alfred Cock.

In examining their works it will be noticed that, as among the painters, several were specially distinguished for their skill in the representation of certain motives—Sosen as a painter of monkeys, Ganku of tigers, Ōkyo of

carp, &c.—so among the founders several are similarly renowned; thus Seimin chiefly owes his fame to the perfect modelling of his tortoises, Toün and Sōmin for the vigour and life expressed in their dragons, and Kamejo for the delicate and truthful rendering of her quails. It is needless to say that they did not confine themselves to these, but executed other works not less demonstrative of their skill.

The human figure, however, does not form part of their naturalistic studies. The forn and movements of lower animal life are e: pressed with a truthfulness which has nev been surpassed, but in representing man the seem rarely to have been able to free then selves from the conventionalities of the a dogmas of the old Sinico-Japanese school and seldom show even traces of that clos observation of nature which characterises the other works.

Fig. 7.

Bronze Brazier by Toün. Bunsei Period, 1818–26 A.D.

One of the finest examples is a seated figure of Ban-kurobé in the garb of a pilgrim, cast by Murata Kunihisa, in 1783 (now in the famous Cernuschi collection, Paris). (Fig. 8, p. 537.)

Portrait statues are of extreme rarity, those representing famous personages being merely conventional creations which are supposed to portray the type or class to which they belonged rather than the individuals themselves. This example would seem to be one in which an attempt has been made to produce with truthfulness a characteristic likeness of the man whom it is intended to commemorate.

With the death of the last representative of this brilliant group of art founders near the end of the first half of the present century, the art gradually passed into a stage of deca dence, the lowest depths of which it bu recently reached, and from which it is onl just emerging.

Vast numbers of bronzes have indeed bee cast, but they are too often of meretriciou design and tawdry ornament, or debase copies of the creations of Seimin, Toün, an their distinguished contemporaries. Fortu nately, there are a few notable exceptions t this later statement. In the first decades c the second half of this century Dōsai, Gidō Sōmin, Joun, Tanchosai, Toryusai, and Izan—specimens of whose works are exhibited—di much excellent work, and ably sustained unde considerable difficulties the reputation of thei famous predecessors. Among more recen

f(ıders a distinguished position should be g :n to Suzuki Chokichi (now living), whose w l-known magnificent example of cera per-d ı casting is in the South Kensington M seum. It is an ancient incense burner w ı doves and peacocks, the doves especially b ıg masterpieces of modelling, and an e ɔodiment in bronze of the highest develop-r ıts of the naturalistic school, of which (ɔkichi is an earnest and ardent follower.

FIG. 8.

:RONZE FIGURE OF BAN-KUKOBÉ. CERNUSCHI COLLECTION, PARIS.

And here I should like to say a word on the cessive crude and vulgar ornament which sfigures too many modern Japanese bronzes. ıch ornament is never found on any vase, azier, or other object intended for use by the ıpanese themselves, but is confined to those ticles specially made for sale to foreigners. 'he collection exhibited to illustrate the rms and ornament of Japanese bronzes :fore the opening of the country to foreign ade amply demonstrates this.) These are l veritable "pot-boilers" cast by men often ıpable of doing better things, who earn more / the production of these vulgar monstrosities r exportation than others who still endeavour follow the simple canons of Japanese art. [odern Japanese bronze founders, like their brethren in pictorial art, hence work in an adverse environment, and under many dis-advantages unknown to their predecessors. In the early centuries religious enthusiasm, the quiet seclusion of the monastery, and the patronage of a powerful priesthood, stimulated, fostered, and supported the old artists in their work so that all their powers were put forth in the execution of the grand masterpieces of those times.

In later times, the same result was achieved under the system of feudalism which prevailed in the country. Workers in bronze were attached to the Courts of the greater daimyos (territorial nobles), their incomes were secure, they were free to work out their designs as they wished, and need only do so when they felt inspired.

During recent years the Emperor has done much for the encouragement of a select few of the chief art workers in bronze in the revival of their old art, the result being that some of the objects of modern work which adorn the Imperial Palace are of extreme beauty, and equal those of the older masters in graceful-ness of form and sobriety of ornament. But for the great majority there is no such patronage, yet the bronze founders must live, and to live means for too many that they must waste their talents in producing work, in designing which they are hampered by the demands of commerce, and the chief, or rather sole, end of which is merely pecuniary remuneration. Up to the 18th century, we rarely find the name of the artist or founder attached to any bronze. Most of the existing specimens of the earlier bronzes were made, as we have seen, for use in the ceremonies and ritual of the Buddhist religion, and were not usually allowed to bear any name, excepting when they were "ex voto" offerings, and then only the names of the donors. The records of the temples are also silent, with few excep-tions, even on the authorship of the grand masterpieces to which they often owe their popularity and fame. The dedicators alone are remembered, and the artists forgotten. Being almost invariably men of plebeian origin, the bronze founders occupied a lower status in life than the caligrapher, painter, or armourer, and their lives have not been thought worthy of record; all the knowledge we have of even the great masters of the last generation is derived solely from their works.

Several charming specimens of both the larger and smaller bronzes—especially of the latter—as late as the last hundred years, are

unfortunately not signed (see especially the candlesticks of fine open work lent by Sir Trevor Lawrence), and many of equal merit are signed by artists whose names do not appear in the lists of noted bronze workers. So that the materials for a history of the men themselves—such as has been compiled of their fellow-artists, the painters—do not exist; and are but scanty and incomplete, even for a record of their works.

This will conclude the first part of my paper. I must apologise for the fragmentary character of the account I have attempted to give you of the rise and development of bronze founding in Japan, and will ask you to regard it merely as a collection of notes which may be of use in the compilation of its history, when further materials are brought to light. I have purposely omitted from it the consideration of the guards (*tsuba*) and other furniture of the sword, because they are more particularly the work of the chaser and carver of metals than of the founder; and also because the subjects of their designs and their technical execution extends over such a wide field, that a special paper would be required for their adequate treatment.

Lantern slides were shown of specimens dating from 1785 to about 1838 A.D:—

18th century. A hawk. From the magnificent collection of Japanese bronzes presented by Monsieur Cernuschi to the city of Paris.

1783. A statue of Ban-kurobé in the garb of a pilgrim. By Murata Kunihisa. Height 2 feet 6 inches measured from the top of the pedestal. Cernuschi collection.

1824. An incense burner. By Ta-uchi and Yaki-yajiro. Nearly 6 feet high. Cernuschi collection.

Beginning of the 19th century. A group of tortoise. By Seimin. Kindly lent by Mr. J. M. Swan, A.R.A.

Beginning of the 19th century, A brazier. By Toün. Kindly lent by Mr. Alfred Cock. Both of these are masterpieces of modelling and casting.

Beginning of the 19th century. An incense burner. By Toün. About 3 feet in height. Cernuschi collection.

The Technics of Japanese Bronze Founding.

Several methods of casting metals have been practised by the Japanese. In the earliest times moulds of stone, in which the shape of the object was cut, sufficed for the simple forms of their ancient weapon; and although they are no longer employed in the casting bronze, their use still survives in the casting lead for some industrial purposes, and of sm silver bars which have subsequently to worked with the hammer into jewellery ar ornaments. Somewhat later, moulds of cl were introduced, probably by Chinese, and is almost certain that contemporaneous wi their adoption, the method of cera perdu casting was first practised.

Casting in moulds of sand or loam is also an early date. In 708 A.D., it was in use the Mint for the production of bronze coin At present it is chiefly employed for small or fl objects—plain or only roughly ornamented- and for castings for industrial uses.

These methods have been followed in som form or other by almost all nations, but may mention *en passant*—although it hardl comes within the scope of this paper—anoth method which is essentially Japanese, *i.e.*, th casting of refined copper in canvas moulds i hot water. Specimens of copper so cast fc the use of the bronze founder are on the tabl It is also used occasionally but rarely fc silver, never for bronze.

One mode of casting they have never prac tised, that is, what is called, the "ascending" method, in which the ingates are so arrange that the molten metal enters the mould at it base, and gradually rises and fills its cavity They have, however, introduced a modificatio in the "descending" or ordinary method— which will be described later—to mimimiz some of its disadvantages, the chief of whicl are, as is well known to founders, the occa sional formation of "cold sets"* on the core and sides of the mould, and unsoundness in the castings due to the entanglement of air in the streams of metal when falling from the top o a high mould.

It will be seen from the descriptions which follow of the operations of the Japanese bronze founder, that, whilst in their general features they have much in common with those of the bronze founder in Europe, they present some differences of greater or less importance. Differences which are chiefly found in certain details of manipulation which are the results of the conditions under which the Japanese founder has worked, the composition of his chief alloy, and the nature of his training.

Before proceeding to consider these opera-

* "Cold sets," metal which has been splashed up against the sides of the mould or core, has solidified there and not afterwards united with the main mass of metal, owing to a film of oxide which has formed on its surface.

ons, we will first glance briefly at the founder, imself. He was—as I have stated above—lmost without exception of the plebeian class f the people, and although many at various eriods were men of marvellous ability and of ie highest merit as artists, yet they seem ever to have ranked higher than artisans. everal sculptors in metal, who were specially istinguished for their skill in the design and rnament of the furniture of the sword, and iany noted smiths, forgers of famous blades nd of armour, were indeed elevated above this rade, and had the honour of receiving com-limentary titles in recognition of their ability; ut I have not succeeded in finding a single xample of an art founder having been similarly ionoured.

No special courses of study, such as were ollowed by painters, were open to him. A nowledge of the principles and practice of his irt had to be obtained under a system of ipprenticeship, which had much in common vith that in vogue in Europe during the latter iart of the Middle Ages, and in which drudgery ind household work absorbed not a little of iis time. As an apprentice, he was bound to erve his master for a fixed term of years, luring which his duties were not only to assist n the actual work of the foundry and studio, ut also to attend to the personal wants of his naster. He lived in his master's house, was ed and clothed by him, and became in fact a minor member of his family.

During his apprenticeship he was taught every branch of the founder's art, from the rough work of mixing and tempering clay for moulds, and the making of crucibles, to the highest stages of designing and modelling objects in wax and of subsequently casting them in bronze. After long years of faithful work, if distinguished by special ability, he might be selected by his master as his successor; and at least, was entitled to receive from him a modest sum of money, either as a loan or a gift, sufficient to enable him to establish a small atelier of his own.

The foundry of the artist always now forms part of his dwelling-house and doubtless this was the case in earlier times. Special rooms are set apart for drawing, modelling, and the preparation of the moulds, the rougher operation of moulding being carried on in sheds at the side of the garden or yard. The foundry itself, in which the metal is melted and cast, is also situated in the yard. A special feature in many is the well-arranged garden on which the modelling rooms open, so that the artist works amid cheerful surroundings, which must influence his work for good.

The working staff consists of the artist, his apprentices, the members of his family, all of whom, even the children, assist in some of the operations, and one or two workmen. Castings from models designed by the artist himself form sometimes the sole work of the foundry, but generally other work is undertaken, and castings are then made of objects which have been modelled by other artists who send their moulds ready prepared merely to be filled with metal.

The Japanese processes of casting bronze and the appliances and materials used, which I shall now endeavour to describe, are those which I have seen from time to time in the art foundries of Ozaka during my residence there, and I have to ask for your indulgence if I burden you with some dry and apparently trivial metallurgical details which may be uninteresting to those who are not specially concerned with the melting of metals. I will, however, try to deal with them as briefly as possible.

This part of my subject may be conveniently divided into the following sections:—

1. Preparation of the mould and core. In clay. In sand or loam.
2. The furnace and foundry appliances.
3. The operations of casting.
4. The alloys used.
5. Stains and patinas.

1. Preparation of the Mould and Core (in Clay).

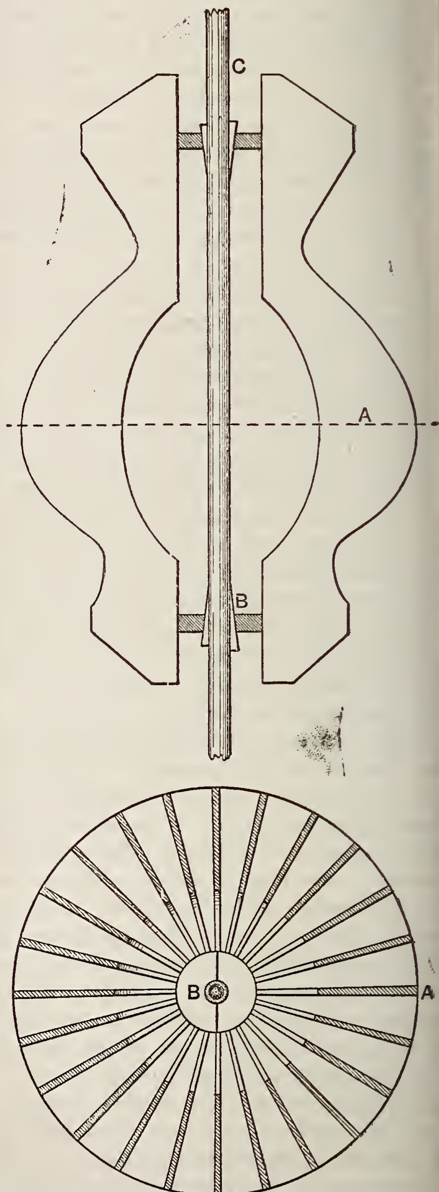
The materials used for modelling and the preparation of the mould and core are as follows:—Vegetable wax, prepared chiefly from the fruit of *Rhus succedanea*; it possesses great fluidity when melted, but has the disadvantage of being extremely brittle in cold weather; bees'-wax; resin, obtained from various conifers, chiefly *Pinus massoniana* and *densiflora*; clay, raw and burnt; river sand; chopped rice straw; rice husks. Various mixtures of vegetable wax and resin, to which bees'-wax is sometimes added, also of bees'-wax and resin alone, are used for modelling, according to the character of the design of the object, and the extent and nature of its ornament. For castings of the highest class, and especially for those with delicate lines and forms or ornament, the latter mixtures are always employed, the former being used only for large or common works of simple shapes, with rough or little

decoration. The clays used in Ozaka and Kyōto are obtained from the hills of decomposed granite in the neighbourhood. They are extremely plastic, but are not very refractory, as they contain considerable amounts of the alkalies.

Great care is devoted to their "tempering," which is effected by many months, even years, of exposure to the weather, with frequent turning over, in the yard or sheds of the foundry. They are always mixed for use with varying proportions of old firebricks, in both fine and coarse powder, and when employed for large or solid cores, with coarsely-chopped rice straw, rice husks, and river sand. Special importance is attached to the use of the oldest clay for the preparation of moulds and hollow cores, as it has been found by experience that they are then much stronger, and less liable to crack than when made of newer material. The amount of rough usage these moulds will bear without injury is very surprising. I have seen them rolled over the rough floor of the foundry, from one end to the other, and yet yield perfect castings. The core, which is one of the most important parts of the mould, possesses some curious features, which are specially characteristic of Japanese foundry practice. For small figures, it is generally solid, and these differ but little from those in common use everywhere; in other cases it is always hollow.

The hollow core—this is used by the Japanese whenever possible—is of two kinds, in one of which it is closed at one end; in the other, both ends are open. The chief peculiarity of the former is its thinness, compared with similar cores in Europe, otherwise it does not differ much from them. I will hence only describe in detail the latter, or open core, as it has many peculiarities, and is particularly distinctive of the methods of founding adopted by artists. In its usual form, its thickness is not much, sometimes not at all greater than that of the outer shell of the mould, in fact it merely forms its inner wall; and, in order that this kind of core may be employed, almost all castings, even of vases, braziers, and similar objects, are cast without a bottom, the bottom being cast separately, and subsequently attached by means of solder. It is usually fashioned on a wooden framework, the parts of which are ingeniously arranged, so that it can be withdrawn as soon as the entire mould has been finished and dried. This framework, an example of which is shown in plan and section in Fig. 9, is constructed as follows:—A sufficient number of flat strip of wood, A A, resembling templates, are pr pared, their external edges being roughly c to the shape of the interior of the article to b cast. Two circular discs of wood, B B, eac

Fig. 9.



Removable Core Frame.

in two segments, and furnished with a central hole, are also prepared to form the top and bottom of the frame. The above strips are then arranged around the peripheries of the discs, and are kept in position by means of

res or cords. A bar of wood, C, of suitable ıgth, is then passed through the aperture in e discs, and the framework is firmly attached it by wedges. The object of this bar is to able the core to be moved about or revolved, ıd so to facilitate the work of the modeller. ıin strips of bamboo, or sometimes a cord of raw, or both, are now bound round the exrior of the frame. The core is then moulded ı it to the proper thickness, with a mixture of ırnt and raw clay and rice husks applied in veral layers, the lower layers being coarser ıd more porous than those above them, and ıe exact form is given to it by one or two nal coatings of clay mixed with sand. After ıe core has been dried, the vase or other bject is modelled on it in wax of the proper omposition (*see* above). Wooden or metal tamps are sometimes used for moulding Chinese characters and parts of the ornament, ut only for the commonest articles, the whole f the modelling of all others being performed y hand.

A drawing or rough model is sometimes sed by the artist for his guidance, but not nfrequently he works without either, and even when using them he does not merely copy heir lines or the exact details of their ornament, in fact, often he departs from them ltogether, if he feels that by a modification f their outlines or decoration the beauty of is subject may be increased.

In preparing this model on the core he exerts his utmost skill; no plaster casts are nade from it; if the casting is a failure his vork—it may have been a masterpiece — is ost, but if successful, it bears in imperishable bronze all the subtle and delicate touches of his hand. When the model is completed, the ngates or openings C C C C and D D D (Fig. 15) through which the metal is poured into the mould, and the necessary outlets for the escape of the air and gases and for running out the wax, are moulded on it, and in some objects pins of bronze are inserted in it to aid in keeping the core in position. The ingates for castings of moderate size, especially for those of considerable height, are not placed only at the top of the mould, but also in one or more tiers around its sides. Thus in Fig. 15 we have four ingates (A A A A) a little above the middle, and three (B B B) on the top of the mould. The object in thus placing them being to diminish some of the disadvantages of the "descending" method of casting which have been previously alluded to. For thin castings this practice is extremely successful, a much smaller proportion being defective from vesicular structure caused by entangled air, from burnt patches, and from "cold sets," than when the ingates are all at the top.

The wax model is now coated with a thin layer of fine clay applied with a brush with great care. After drying, other layers are similarly applied, until the crust is sufficiently thick to permit additional layers of somewhat coarser clays to be put on with the hand and tools, to give the requisite strength to the mould. The mixture of clays for the first layers is very carefully prepared, and is sometimes mixed with finely powdered porcelain to prevent them from being melted by the molten metal. The formation of a fused crust on the casting, which is always difficult to remove, destroys its surface, and mars the sharpness of its designs, is thus avoided.

The mould is then dried very slowly in a warm part of the foundry. When dry, the wooden core is removed, and the wax is then melted out by means of a carefully regulated charcoal fire, by which both the hollow core and the outside of the mould are heated, and at the same time all traces of moisture are expelled and its walls baked hard.

Preparation of the Mould (in Sand or Loam).

Moulding in sand or loam has not been extensively practised by the Japanese for artistic castings, with the exception—as I have stated above — of flat objects, such as coins and mirrors, and others of simple forms, in which no parts of the ornament are in undercut relief. Even in many cases in which the use of a sand or loam mould was perfectly admissible, a clay mould seems to have been preferred because it could be heated before it was filled with metal, a point to which much importance is attached. Their methods of moulding in sand do not differ greatly from ours, I will hence only describe that followed in the old Mint, about sixty years ago, where this kind of moulding was brought to a high state of perfection for casting the bronze coins known as "tempo."

Specimens of these coins and of mirrors cast in the same way are exhibited.

The model, or "mother" coin as it was termed, was prepared in bronze, either by the "cera perduta" method or by cutting and engraving. For mirrors and similar objects this or a model in wood was used as the "pattern," but for coins, when many had to be cast, the "patterns" were prepared first by casting from the "mother" coin what were

termed "seed" coins in pewter, and then from these the actual working "patterns" in bronze.

Lantern slides were shown illustrating the operations of moulding and casting in the old Mint in Yedo in 1835, as follows:—

Filling the mould frame with sand.

Moulding by means of the metal patterns.

Smoking the moulds.

Pouring the bronze into the vertical sand moulds, see Fig. 10.

FIG. 10.

POURING THE BRONZE INTO A VERTICAL SAND MOULD.

The "flask" or frame for holding the sand was of wood, without transverse or longitudinal ribs. It was placed on a flat board on the floor of the moulding-room, where it was filled with damp sand—the sand being well trodden to consolidate it—the excess was scraped off and the surface made level and smooth. Upon this surface, which was first dusted with charcoal powder, two bronze rods to form the ingates and main feeding channels were placed, and on each side of them a row of the metal "patterns," all being carefully pressed into the sand. Another frame was then placed upon it and filled with sand which was also very carefully trodden. The frames were then separated, the "patterns" removed, and a small channel was cut from each cavity in the mould leading to the main channel. They were

ow placed on an open frame and their inner urfaces were smoked with burning pine-wood eld below them in a brazier. After being gain fitted together they were placed between wo boards and firmly braced up, and then set p vertically in the melting-room to receive the ronze.

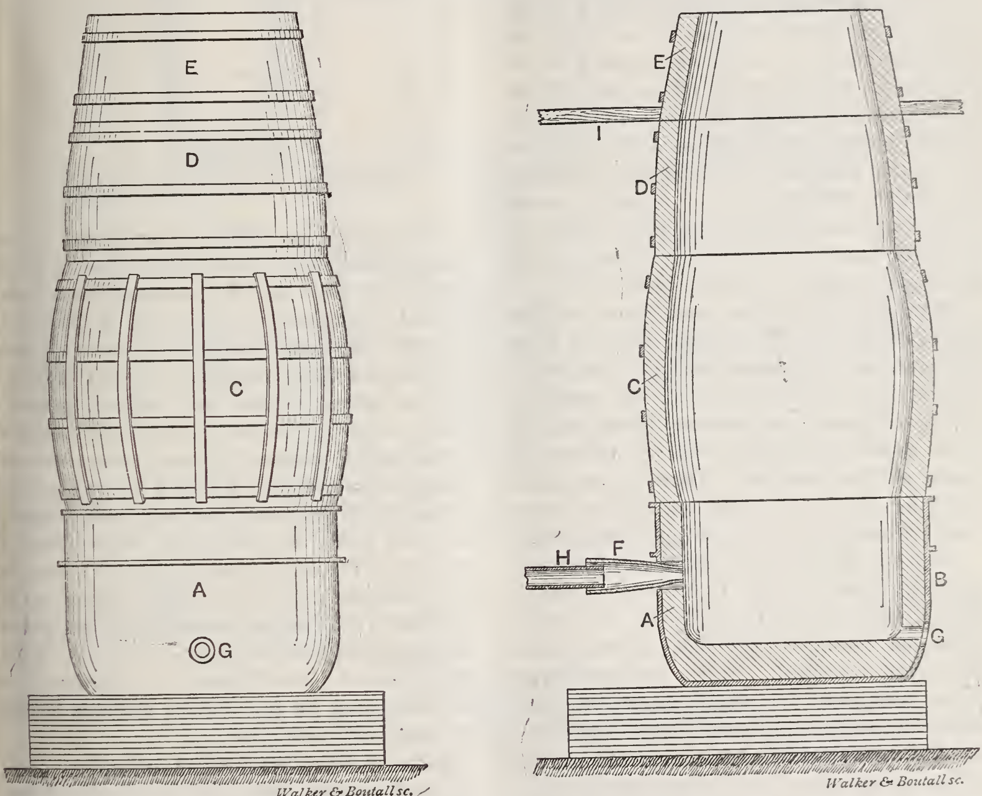
. The Furnaces and Appliances of the Foundry.

The furnaces and appliances which are used y Japanese artists for melting and casting ronze are of a very simple character. They consist of a series of cupola furnaces in segments, several crucible furnaces, and two kinds of blowing machines.

Reverberatory furnaces were not employed by the old founders, but during recent years several have been erected from my designs in Government and other establishments, chiefly however for the production of ordnance and castings for industrial purposes.

When small castings only are required the bronze is generally melted in crucibles, but for those of larger dimensions a cupola furnace, or more than one, is always employed.

Fig. 11.



Typical Cupola Furnace for Melting Bronze.

A, lower segment of the furnace; B, iron pan enclosing the furnace; C, D, E, upper segments; F, twyer; G, tap-hole; H, pipe leading the blast from the blowing machine; I, charging floor.

A typical cupola furnace, which is that which was actually used in the casting operations to be described subsequently, is represented in Fig. 11.

It is very ingeniously constructed of cylindrical segments. The lowest, which forms the hearth, consists of a cast-iron pan lined with fireclay, and a coating of brasque, composed of clay and charcoal. It is furnished with an aperture, G, in front, for tapping out the metal, and another at the back for the insertion of the twyer, through which the blast is introduced. Each of the other segments consists of a cylinder of fire-bricks or slabs, cemented together with fire-clay, and firmly bound with iron bands. The number and size of these segments used in erecting a cupola depends on the quantity of

metal it is intended to melt at each charge, and as a considerable number of various sections and degrees of taper are kept on hand, any form can be given to the interior of the cupola. In all well-arranged foundries these segments, with their accompanying hearths of various sizes—generally from 1 foot to 2 feet 3 inches in diameter—are always ready, so that a furnace can be built up without delay at any time, for either large or small meltings.

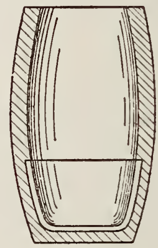
The cupola is erected by placing the hearth-segment on a platform of brick, about 1 foot high, so that the taphole may be of a convenient height for tapping. Upon this segment one of the others is placed, and luted to it with fireclay; another is placed on this and similarly luted, and others are added if necessary, until the furnace is of suitable height. The advantages which this method of erecting cupola furnaces possesses for small foundries, where the work is of an irregular character, and where castings are often urgently needed which are too large for crucibles, and too small to justify the lighting up of a large permanent cupola, are self-evident.

There is only one twyer, and this is the chief disadvantage of the larger sizes of these furnaces, as it causes an unequal distribution of heat in the zone of fusion, the results of which are undue volatilisation of lead and zinc in the overheated spaces, and an unnecessary waste of blast and fuel. There is no special charging door, the fuel and metal being simply thrown into the open top of the furnace.

Portable Furnace for Melting Bronze.—Another furnace which is not now in use in Japan, but is still employed in China, resembles the hearth segment of the cupola I have just described. It is, however, made light and portable, stands on three feet, and is fitted with sockets in its sides, into which long handles are inserted, so that it can be carried by two or four men. It is placed in front of a bellows, as shown, and then charged with charcoal and bronze. When sufficient of the latter has been melted, it is carried to the mould, the fuel raked off, and the molten metal poured through a beak-shaped opening in its side.

For objects of small size and complicated forms and of delicate modelling, the bronze is melted in crucibles in small furnaces, which, like the cupola, are worked by means of a blast. This form of furnace consists of a simple cylindrical chamber, with a lining of fireclay, generally partly embedded in the ground of the melting-room, and fitted with a moveable clay cover. Its sides are pierced with four or six or more holes, about three to five inches above its base, for the admission of the blast. The fuel used is charcoal. Recently, air furnaces connected with chimney stacks, similar to those of Europe, have been erected in many foundries, but the above form is still in extensive use in the melting-rooms of artists.

Fig. 12.



Crucible for Melting Bronze.

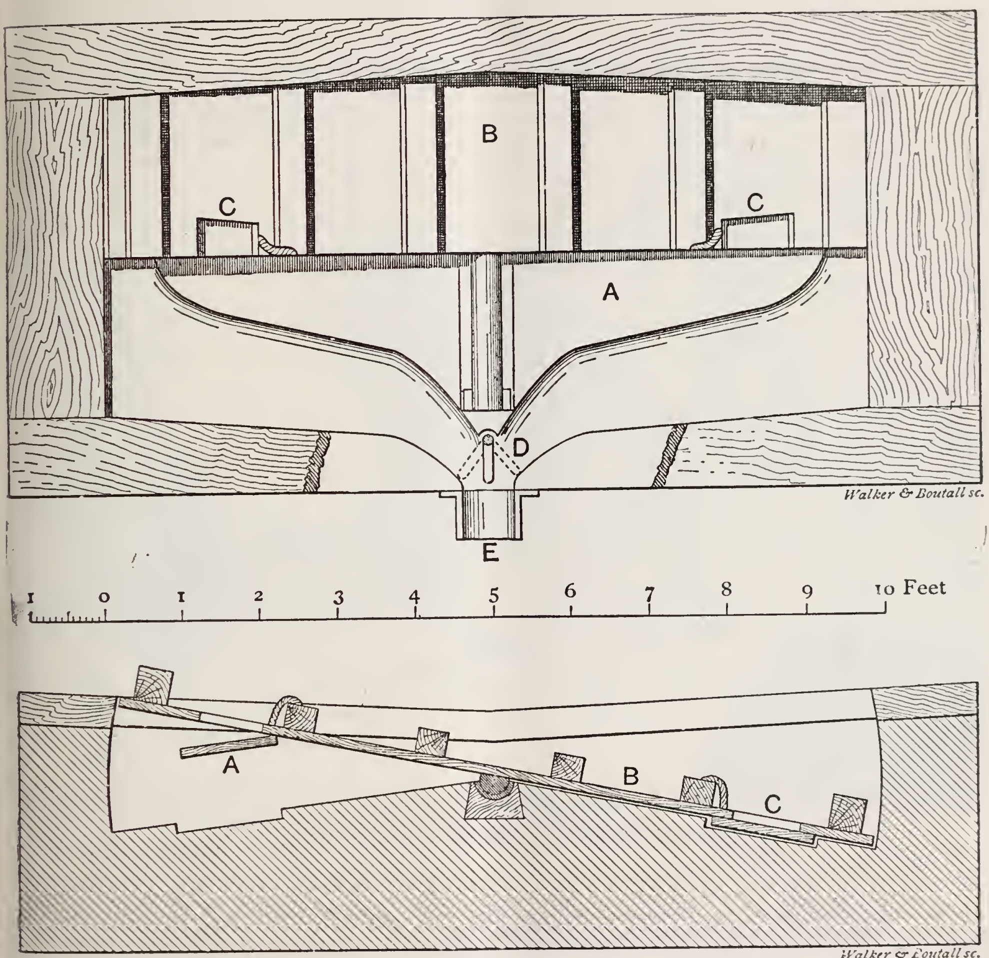
The crucible used (Fig. 12) consists of a thin inner crucible of porcelain enclosed in an outer one of fireclay; and its construction affords a good example of the ingenuity of the Japanese in overcoming the difficulties arising from the non-refractory character of their fireclay. As has been pointed out already, granitic clays, not very infusible, are alone available for metallurgical purposes in Japan, porcelain clays being expensive and reserved for the potter. If the crucible were made entirely of the former, it would soften and crack at intense heats; hence it is lined with a cup of difficultly-fusible porcelain just at that part where, owing to the position of the twyers, the temperature of the furnace is extremely high; so that, even if the outer part is partially fused or destroyed, the metal will not be lost, but be retained by the porcelain cup within it.

Blowing Machines.—The machines used for producing the blast cannot be passed over without notice. They are of two kinds, both of which are peculiar to the East, and although defective in many respects, when compared with the more perfect forms of blowers, such as Baker's and Root's in use in this country, and also in the large commercial and Government works in Japan; yet their convenience and efficiency is sufficiently great to enable them to hold their own in the art foundries, where, indeed, they are still universally employed. One of these, called the "Fuigo," is shown in the lantern slide. It is used for producing the blast for the crucible furnace

previously described, and also very extensively for other metallurgical operations, such as copper, lead, and tin smelting. As the Chinese form, with which it is almost identical, has been described more than once, I will not trouble you with a detailed account of it. It is essentially a rectangular wooden box fitted with a piston, which is worked horizontally, and with four valves so arranged that it is double-acting, a blast being produced by both the forward and backward motion of the piston. The air chamber generally measures about 3 feet by 1 foot 10 inches by 7 inches.

The other blowing machine, which is called "Tatara," appears to have escaped the observation of foreign writers, as it has not hitherto been described. Fig. 13 represents it in plan and sections. It consists of two air-chambers, A, A, in some cases constructed of wood, in others of clay with merely a lining of wood at their sides. The bottom of each chamber is an inclined plane sloping from a central ridge. The top of this ridge is fitted with metal bearings, in which the axle of the pressure board, B, works. The pressure board is made of wood, and is fitted with two valves, C, C, opening inwards, one being placed at each end. Its edges are sometimes lined with a packing of fur or feathers, so that it may fit closely to the sides of the chamber and leakage of air be prevented.

FIG. 13.



JAPANESE BLOWING MACHINE, CALLED "TATARA."

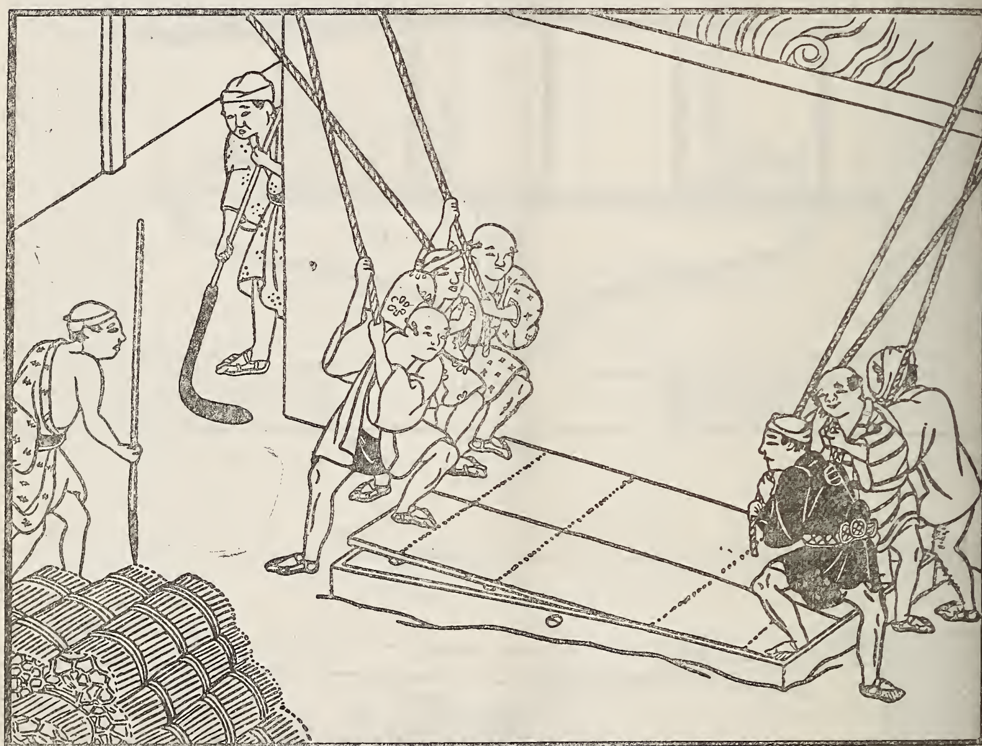
A, A, air chamber; B, pressure board; C, C, valves of pressure board; D, blast valve; E, blast outlet.

About eight or ten persons are required for working one of these machines in melting bronze, and often the whole of the artist's

household—men, wowen, and children—aid in the operation. A rocking motion is given to the pressure board by the workers stepping alternately on and off either end (Fig. 14), and the air is thus compressed first in one chamber, then in the other, and passes to the blast-outlet, E, through a channel at the bottom and front of each. At the junction of these channels with the blast-outlet, a flap valve, D, closes either channel when the opposite half of the pressure board descends. The workers are aided in stepping on and off by ropes hanging from the roof which they grasp with their hands, and in keeping time—and the efficiency of the machine depends greatly on this—by singing songs which have been specially composed for them.

The blast is intermittent, irregular in pressure, and deficient in volume; and the effective power of a machine worked by eight men does not exceed one ton of cast iron melted per hour, the cost of the labour however being only about 8d.

Fig. 14.



Working the Blowing Machine called "Tatara."

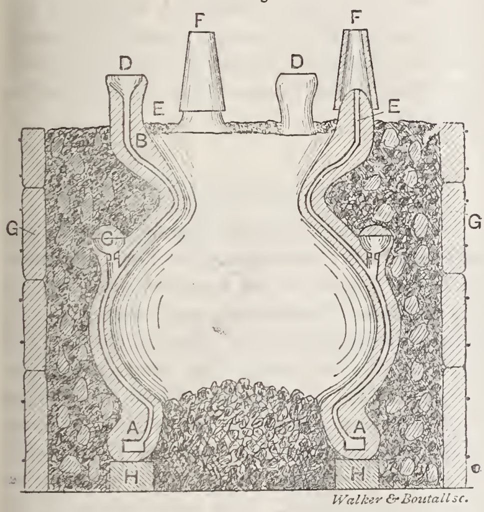
The Operations of Casting.—The metal used for the charges of a cupola furnace when a "cast" has to be made, consists either of old bronzes and defective castings, or more generally of a mixture of these with new alloy. The separate metallic constituents of the bronze, viz., copper, tin, lead, or zinc, do not form part of these charges, but the alloy is previously prepared by melting them together some days beforehand. The alloy then obtained is cast into thin plates, which are broken up whilst hot, and the fragments are used for the casting charges. When crucibles are used, the alloy is however frequently made at the time of casting, although for castings of special importance, bronze which has already been once or oftener cast is always preferred.

For my description of the operations of casting I have selected the casting of a brazier in the mould shown in Fig. 15, as it is a typical example of Japanese practice, and I was present in the foundry during the whole of the operations.

The bronze was melted in the cupola furnace (Fig. 11). Charcoal was used as fuel, and the blast was produced by a "tatara" worked by eight persons.

From an early hour in the morning, and whilst the melting was proceeding, the foundry staff was engaged in preparing the moulds for the reception of the metal by heating them to redness. This was effected in the following manner. The mould (Fig. 15) was placed on five or six bricks, H, H, to raise it above the earthen floor of the melting-room. Its ingates, C, C, C, C, and D, D, D, D, were closed with stoppers of clay and the conical tubes,

Fig. 15.



Mould with Open Core, Showing the Mode of Heating it.

A, A, outer wall of the mould.
B, B, inner wall of the mould (or core).
C, C, lower ingates.
D, D, upper ingates.
E, E, vents or outlets for the air and gases.
F, F, fireclay tubes.
G, G, fireclay slabs.
H, H, firebricks.
I, I, ignited charcoal.

F, F, were fitted over its air outlets, E, E, to prevent any fuel from falling into them. A wall of fireclay slabs, G, G, was now built up around it, the slabs being kept in position by hoops and bands of iron and an external luting of clay, a space about three inches wide at its narrowest part being left between the inside of the wall and the outside of the mould. A charcoal fire was then made on the floor below the mould, and the space between the wall and the mould was completely filled with burning charcoal which was mixed with fragments of bricks and crucibles to prevent the heat from becoming too intense. The interior of the core was also partly filled with the same mixture, and two clay tubes were fitted above it to serve the purpose of chimneys. The temperature of the interior was regulated by partially or entirely closing the upper openings of these tubes with tiles. The mould was kept at a red heat for more than two hours, by which time the metal was nearly ready. The wall of clay slabs and the draught tubes were now rapidly taken down and the fire was raked away. The bricks, H, H, supporting the mould were carefully removed and the holes through which the wax had run out stopped up with fireclay. During their removal the floor below was sprinkled with water and softened by shovelling, and on this the mould was allowed to rest. Large stones were now piled around its base to steady it and the stoppers were removed from the ingates. The ingates, of which there were seven—four about the middle of the mould and three at the top—were fashioned in the form of small cups of fireclay, about two inches in diameter, each having three aperatures half-inch in diameter opening into the channel leading into the mould.

The mould was now ready for receiving the metal. On looking into it through one of the ingates it was seen to be at a dull red heat. The bronze was then tapped into four iron ladles, each of which was held by a workman, and a small quantity of wood ashes was thrown upon its surface. The workmen then took up their positions opposite the lower ingates and on a signal being given poured the contents of their ladles simultaneously into the mould. The quantity of metal had been very accurately estimated as it just reached about half way up each ingate. These ingates were then closed with clay stoppers luted in with fireclay. Three of the ladles were filled again and poured in the same manner as before, but into the upper ingates, completely filling the mould. During pouring very finely powdered rice bran was thinly sprinkled on the metal as it flowed from the mouths of the ladles. The mould was allowed to stand for six hours before breaking it from off the casting. Several other smaller moulds were then filled in a similar manner, and as one ladleful of metal was sufficient to fill each, they had only one ingate and one air outlet. Whilst the bronze was being poured into them they were rather vigorously tapped with a short stick to dislodge any air bubbles which might have adhered to their sides.

For castings of very large size ladles are not

used, but the bronze is run from one or more cupola furnaces, first into a receptacle lined with fireclay, and then from this through an aperture in its bottom into the mould. The outflow is regulated by means of a plug, so that a considerable depth of metal is always retained in the receptacle in order that scoriæ and oxidised scums may be prevented from entering the mould. To prevent oxidation as far as possible, the surface of the metal is kept carefully covered with a layer of charcoal or of partially carbonised straw.

A subsidiary, but often necessary part of the founder's work, and one in which the Japanese exhibit very great skill, is the repairing of any defects that the castings may show on their removal from the moulds. Thus, for example, occasionally the rim or or other part of a vase may be imperfect owing to the retention of air in the mould when the metal was poured in. In this case the imperfect part is carefully remodelled in wax on the defective casting, a clay mould is made over it in the usual way, and the wax is melted out. A certain quantity of metal is then poured in and allowed to run out until the edges of the defective part have been partially melted, when the outlet is stopped and the mould allowed to fill. When it has solidified, the clay mould is broken away and the excess of metal filed off.

Handles and ornamental appendages, which have been separately cast, are frequently attached to objects in this manner. Separate parts of complicated groups and of colossal figures are similarly united, and often this is so skilfully done that it is impossible to say whether the whole is a true single casting or is composed of several pieces which have been separately cast.

Rude as the appliances and methods of the Japanese art founder, which I have just described, may seem to us, he has produced with them castings in bronze on all scales which, with all the modern equipments of our foundries, it would be difficult for us to excel. The simplicity, adaptability, and portable character of his appliances have been of special advantage to him in his remarkable achievements in colossal castings. Thus, when a huge image of a Buddhist divinity or a bell of unusual weight was required for a temple in any locality, the whole of the operations were conducted on the spot. Temporary sheds for the modelling were erected in the temple grounds. The furnace and blowers were transported thither in segments; sometimes the latter were even made by the local carpenters. If the casting had to be made in one piece, the necessary number of cupola furnaces, each with its blower, were erected around the mould. The cost of the blast was *nil* as the services of any number of eager volunteers, from the crowds which congregated at the temple festival on the day of casting, were readily obtained for the meritorious work of treading the blowing machines. In this way the great bells and colossal images were cast.

It may be interesting to note here, that the methods of heating the mould and of repairing defective castings were in use in Europe during the 10th and 11th centuries, and doubtless at a very much earlier date. They are described by Theophilus in his valuable treatise, "De Diversis Artibus," written in the early half of the 11th century, and his description is practically identical with that I have just given you of them as they are practised in Japan.

The Alloys Used.

The success which the Japanese artist has attained in the execution of his famous masterpieces in bronze is not however solely due to his methods of modelling and casting, but is largely dependent on the physical character of the alloys he has used. His alloy *par excellence* is called "karakane"—which signifies "Chinese metal"—this name having been given to it because it is believed not to have originated in Japan, but to have been introduced from China. The exact date of its introduction is unknown, but there is little doubt that it was not later than the 7th century when the bronze coins in circulation in the country were chiefly Chinese, and it was probably in this form that the Japanese first became acquainted with it. The name "karakane" does not however designate any definite alloy. It has a generic rather than a specific signification, and is applied to a very varied group of mixtures of metals of the copper-tin-lead series, in which the proportion of copper may range from 71· to 89· per cent., of tin from 2 to 8 per cent., and of lead from 5 to 15 per cent.

The Table No. II. which follows contains all the analyses of the alloys bearing this name which have been published by various analysts, as well as some which I have made myself of typical specimens. It also includes several other allied alloys which are not in such general use as "karakane," but are valuable for special purposes.

TABLE II.—ANALYSES OF JAPANESE BRONZES ("KARAKANE") AND ALLIED ALLOYS.

Description.	Analyst.	Copper.	Tin.	Lead.	Arsenic.	Antimony.	Zinc.	Iron.	Silver.	Sulphur.	Gold.	Nickel	Total.
1. Temple Bronze	Maumené	88·70	2·58	3·54	—	·10	3·71	1·07	—	—	—	—	99·70
2. Incense Burner; 18th century	Gowland	86·85	1·76	9·13	1·15	·40	nil.	·33	·079	—	trace	—	99·699
3. Temple Bronze	Maumené	86·38	1·94	5·68	—	1·61	3·36	·67	—	—	—	—	99·64
4. Vase, 18th century	Geerts	85·3	8·9	4·7	trace	—	—	1·1	—	—	—	—	100·0
5. Cannon, 18th century	Gowland	84·00	12·68 by diff.	3·32	—	—	—	—	—	—	—	—	100·00
6. Vase, 18th century	Geerts	83·70	5·38	7·80	trace	—	·185	·65	—	—	—	—	99·38
7. Coins, "Bunkyu," 1863	Gowland	83·10	3·21	11·22	1·50	·49	nil.	·27	·06	·38	trace	—	100·23
8. Old Bronze Ornamental Vessels, probably vases	Morin	83·09	3·23	11·50	·25	—	·50	·22	—	—	—	—	98·79
9. Old Bronze Ornamental Vessels, probably vases	Morin	82·90	2·64	10·46	·25	—	2·74	·64	—	—	trace	trace	99·63
10. Old Bronze Ornamental Vessels, probably vases	Morin	82·72	4·36	9·90	trace	—	1·86	·55	—	—	—	—	99·39
11. Modern Ornament; a Tortoise	Roberts-Austen and Wingham	81·62	4·61	10·21	—	—	—	—	—	—	—	—	99·08
12. Coins, "Tempo," 1835 to 1870, A.D.	Gowland	81·31	8·26	9·74	·18	·03	·19	·06	·037	·08	—	—	99·887
13. Vase (?), old	Morin	81·30	3·27	11·05	trace	—	3·27	·67	—	—	—	—	99·56
14. Temple Bronze	Maumené	80·91	7·55	5·33	—	·44	3·08	1·43	—	·31	manganese trace	—	99·05
15. Coins, "Do-sen," 1636 to 1768 A.D.	Gowland	77·30	4·32	15·33	1·14	·31	nil	1·01	·06	·52	trace	—	99·99
16. Vase, or Ornament	Kalischer	76·60	4·38	11·88	—	—	6·53	·47	—	—	—	—	99·86
17. Temple Bronze	Maumené	72·09	5·52	20·31	trace	—	·67	1·73	—	—	—	—	100·32
18. Ornament	Geerts	71·00	5·50	20·35	—	—	1·34	1·84	—	—	—	—	99·93
19. Mirror, 17th or 18th century	Gowland	95·04	·58	3·19	·14	—	—	·04	1·13	·04	trace	—	100·16
20. Mirror, modern	Atkinson	76·28	23·64	·13	—	—	—	—	—	—	—	—	100·05
21. Mirror, modern	Hochstetter Godfrey	75·05	16·95	7·63	—	—	—	—	—	—	—	—	99·63
22. Bronze for Soldering Copper	Hochstetter Godfrey	67·87	29·92	·89	—	—	—	1·19	—	—	—	—	99·87
23. Solder for Bronze	Hochstetter Godfrey	37·04	—	1·01	—	—	61·63	·25	—	—	—	—	99·93
24. Brass Coins, "Shimon-sen," 1768 to 1860 A.D.	Gowland	75·62	·73	2·85	1·99	·14	16·54	1·76	·016	·03	trace	—	99·736
25. Brass Temple Vase, 18th century	Gowland	74·52	·79	5·50	·12	trace	19·14	·15	—	trace	—	—	100·22
26. Yellow Bronze, "Sentoku"	Roberts-Austen and Wingham	72·32	8·126	6·217	—	—	13·102 by diff.	·170	—	—	bismuth trace	·065	100·000

TABLE III.—ANALYSES OF ANCIENT BRONZES OF VARIOUS COUNTRIES CONTAINING LEAD.

Description.	Analyst.	Copper.	Tin.	Lead.	Zinc.	Iron.	Silver.	Arsenic	Gold.	Sulphur	
Figure of Osiris, Egypt [date ?]	Gladstone	87·1	6·3	4·4	—	trace	—	—	—	—	
Celtic Armlet, prior to Roman occupation	Church	8 ·49	6·76	4·41	1·44	—	—	—	—	—	
Fragment of Drapery, Greek, 450 B.C. (Brit. Mus.)	Roberts-Austen & Wingham	84·49	9·47	5·31	—	trace	—	—	—	—	
Figure of Isis, Egypt, Ptolemaic time	Flight	82·19	2·02	15 79	—	—	—	—	—	—	
Greek Vase, time of Alexander the Great, 336 to 324 B.C.	Flight	81·764	10·901	5·246	—	·153	trace	—	—	trace	Cobalt 1·222. Nickel trace.
Coin, Claudius Gothicus, 268 A.D.	Phillips	81·60	7·41	8·11	—	—	1·86	—	—	—	
Roman Statue of Victory, Brescia, [date ?]	—	80·8	9·4	7·7	1·9	—	—	—	—	—	
Figure of Apollo, from Orange (Brit. Mus.), 1st. cent A.C. [?]	Roberts-Austen & Wingham	80·70	6·44	9·97	trace	trace	trace	—	—	—	
Coin, Julius and Augustus, 42 B.C.	Phillips	79·13	8·00	12·81	—	trace	—	—	—	trace	
Buckle from Bohemia, prehistoric	—	76·9	9·3	7·7	—	2·9	—	—	—	—	
Coin, Roman As Quadrans, *c.* 500 B.C.	Phillips	72·22	7·17	19·56	—	·40	—	—	—	—	Cobalt ·28; Nickel ·20.
Statuette (fragment), Egypt [date ?]	Bibra	71·46	3·60	21·54	3·07	·08	—	—	—	—	Antimony ·10. Nickel ·13.

And as a comparison of the alloy "karakane" with similar alloys of other countries is of considerable metallurgical as well as historical interest I have given in Table No. III. some analyses of several ancient objects which will enable this comparison to be made.

I would also call your attention to a very valuable series of analyses of Oriental art metal work made under the direction of our chairman, Professor Roberts-Austen—who has won special distinction for his researches on alloys—and published by the Science and Art Department.

It will be seen from Table II. that the presence of lead, as an important constituent, is one of the characteristic features of the composition of the Japanese bronze "karakane," although —as is shown in Table 3—it is not peculiar to them. Several reasons have been advanced for the origin of the presence of this metal in copper-tin alloys; those, however, we need not discuss here. One thing is certain, that even in very early times, the relative properties of copper-tin and copper-tin-lead alloys were known, as in almost all specimens which have been analysed, swords, and weapons in which strength and hardness were essential, consist of the former (copper-tin), and coins, decorative objects, and figures, in which these properties were not necessary, of the latter (copper-tin-lead).

The wide range in the proportions of the constituents of "karakane" is fully demonstrated by the analyses given above. This variability in composition is not solely the results of attempts on the part of the founder to produce special alloys, as might be conjectured, but is chiefly owing to the practice universally adopted of mixing considerable quantities of old metal "scrap," of unknown composition, with the furnace charge, even when the copper, lead, and tin of the same charge have been carefully weighed in definite proportions, a practice not altogether unknown in this country. In the case of the temple bronzes, it is generally due to their having been cast from accumulations of *ex voto* offerings of the most heterogenous character.

A few words on the purity of the metals used by the Japanese in preparing their alloys may not be out of place here. The copper, as will be seen from the following analyses, is almost, without exception, extremely free from the injurious metals—arsenic, antimony, and bismuth:—

Japanese Copper Refined by Native Processes.

	Nobe-ji.	Akita.	Omodani.	Sumitomo (ma-buki-do).
Copper ..	99·30	99·55	99·80	99·24
Lead	·55	·23	·12	·49
Iron......	·10	·15	trace	·05
Arsenic ..	trace	trace	,,	·04
Antimony	,,	nil	nil	trace
Silver	·025	·009	not determined	·022
Sulphur ..	trace	·03	trace	·01
Bismuth ..	nil	nil	nil	nil
	99·975	99·969	99·92	99·852

Imperfectly refined copper, containing larger proportions of sulphur and iron than those given above, but still comparatively free from arsenic, antimony, and bismuth, is sometimes used. When Japanese castings are unsound from vesicular cavities, the unsoundness is generally due to the sulphur in such copper. The sulphur becomes oxidised, during melting and pouring the alloy, to gaseous sulphurous anhydride, and the cavities are formed by bubbles of this gas being retained in the casting during solidification. In our own foundries this element is also, too frequently, the unsuspected cause of the same defects in castings.

The tin used generally contains lead, occasionally iron and copper, but rarely other impurities.

The lead is tolerably pure, excepting that it always contains a little silver.

Zinc, which is of frequent occurrence in Japanese bronzes (karakane), has never been added as metal, and its presence is due to the brass articles which often form part of the "scrap" of the furnace charges.

The presence of arsenic and antimony, both of which are often found in considerable amounts in these alloys, is not due to the use of impure metals, but to the addition of a pseudospeise called "shiro-mé" — a by-product of the desilverisation of copper by lead*—the composition of which is given in the following analysis, which I have made of a characteristic specimen.

	Shiromé.
Copper	72·70
Lead	8·53
Arsenic	11·37
Antimony	4·27
Tin	0·93
Iron	0·13
Silver	1·33
Sulphur	0·33
Zinc	nil
Gold	trace
	99·59

The first official record we have of the use of this pseudospeise is contained in an edict of the Government in 1764, prescribing its addition to the copper-tin-lead bronze to be used in the Mints for the casting of coins, but doubtless it had been similarly employed very much earlier than that date, and almost certainly in the casting of the colossal Buddha in Kyoto in 1614 A.D. It was added to the alloy in order to increase its hardness without diminishing its fusibility, and to obtain in the castings a sharper impression of the mould than was possible with the copper-tin-lead alloy alone. During later years it has been used by some bronze founders because its addition to "karakane" has been found to facilitate the production of the grey patina, which is preferred for objects which have to be decorated with inlaid line designs in silver.

It is almost needless to say that silver, although mentioned in temple records as having been added to the bronze used for the casting of some of their famous images and bells, has never been so added, as there is never more present than can be accounted for by its occurrence in the copper, lead, or shiromé used. Mercury and gold, which are also erroneously recorded as constituents of some noted bronzes, do not exist in the alloy, and can only have been used for gilding their surfaces. Patches of gold have however been employed for the decoration of some ancient bronzes.

The chief characters on which the value of the Japanese copper-tin-lead alloys, as art bronzes, depend may be briefly stated as follows:—

1. Low melting point. This is of especial importance to the Japanese founder owing to the fusible nature of the clays and sands of which his crucibles and moulds are made.

2. Great fluidity when melted compared with the sluggishness of copper-tin bronzes.

* "A Japanese Pseudospeise," by W. Gowland. "Jour. Soc. Chemical Industry," vol. xiii. p. 463.

3. Capability of receiving sharp impressions of the mould.

4. Their contraction on solidification is not excessive.

5. Their peculiar smooth surface.

6. The readiness with which they acquire rich patinas of many tints when suitably treated.

The advantages resulting from the above properties will be obvious to all artists in bronze. They are chiefly the result of the use of lead as one of the chief constituents of the alloys. The low melting point of these bronzes, their fluidity when melted, and the facility with which they acquire certain patinas are indeed entirely due to the use of this metal. The fine velvety surface and sharpness of the castings depend in a great measure on the structure of the mould and its comparatively high temperature when the bronze is poured into it, although partly also on the influence of the lead. These alloys are, however, not without some disadvantageous physical properties, and these are also due to the lead which they contain. They are often low in tenacity, and offer but little resistance to bending and torsion when compared with simple copper-tin bronzes, even when they contain sufficient tin to enable them to hold more lead in solution than they would otherwise do. Their use is hence almost limited to the production of objects of art. And even for those art castings, such as, for example, large equestrian or other statues, where a considerable strain has to be borne by certain parts, their use is unadvisable. But in most art castings of moderate size—and even in many of colossal proportions, where the position of the centre of gravity of the mass does not cause excessive tension in any part—it is not necessary that the metal of which they are cast should possess great tenacity; for all such, these alloys are eminently adapted, and especially so, as by no others can the work of the artist's hand with all its delicate and masterly touches, be so readily and perfectly reproduced.

I do not think they could be advantageously used for statues or monuments exposed to the weather in the impure atmosphere of our great towns, but for castings protected from these combined adverse influences, I think the Japanese bronze, "karakane," is worthy of a trial. As we have seen, the Japanese founders have no fixed or standard composition for their alloy, I may hence be permitted to suggest the proportions in which, in my opinion, the metals should be mixed to produce a bronze which—for castings of moderate size and thickness would secure many of the advantages possessed by it. They are as follows:—

	A.		B.
Copper	88·0	....	88·0
Tin	7·0	....	6·0
Lead	5·0	....	5·0
Zinc	0·0	....	1·0
	100·0		100·0

The zinc to be omitted from castings with very delicate lines of ornament.

Specimens of each of these alloys are on the table for your inspection, also a specimen of ordinary gun-metal, C, containing 2 per cent. of zinc for comparison with them. They do not differ much in tensile strength, that of A being 13·25 tons, of B, 12·19 tons, and of C, 14·29 tons per square inch. These alloys have been kindly prepared for me, and their tensile strengths determined by the Broughton Copper Company (Manchester), who are specially skilled in the manufacture of copper alloys.

The other alloys which are not contained in the "karakane" group, do not require a lengthy consideration, as they are much less frequently made use of by artists. Thus the simple copper-tin alloys which were employed in prehistoric times, are not found in use after the introduction of "karakane" from China until comparatively recently, and then only occasionally for mirrors.

Neither have the copper-zinc alloys, "Shinchu," or brass (Table II., Nos. 24 and 25), been much in favour among artists. They were unknown in Japan before the establishment of Buddhism, and were probably introduced contemporaneously with that religion from China (6th century A.C.). Their use in art has been almost exclusively restricted to the production of the ceremonial vessels and utensils of temples and shrines, and especially for the "Go-gusoku," or Five Ornaments of the Buddhist altar.

Even when a yellow metal is needed for the purposes of decorative ornament, brass is seldom used, copper coated with gold being preferred, the rich colour and quality of the gold surface being more pleasing to the Japanese than the harsher tones of the copper-zinc alloy. Hence there is scarcely a single example in the country of any great work of art executed in brass.

Occasionally, the yellow bronze, "sentoku" (Table II., No. 26), consisting of copper, tin, and zinc—an alloy occupying an intermediate position between "karakane" and brass—is

used instead of the latter alloy. It is, however, probably not older than the 15th century. An old Chinese legend records that it was accidentally discovered after the destruction of a temple by fire, when the bronze, brass, and gold vessels of the altar were melted together into a mass. The beautiful colour of the metal attracted the attention of some art founders, who, after numerous unsuccessful attempts, at last succeeded in producing an alloy resembling it. Gold is said to be an essential ingredient in its composition, but I have not found any in the specimens I have examined. It is not in very common use. Vases and other objects cast of it—generally with but little ornament in relief—are occasionally met with, but the finest specimens are found amongst the guards and other ornamental furniture of the sword, and all are chiefly notable as examples of chasing, rather than of founding, or for the beautiful colour and texture of their surfaces.

The method of preparing or melting bronze is, as is well known to all founders, secondary only to its correct composition, and as it has such an important influence on the character of the castings, one or two points relating to it, derived from my own experience, may be briefly considered here. Cupola furnaces should never be used for any bronze castings. If coke is employed as fuel in them the metal will be contaminated with sulphurous anhydride (SO_2), and the castings will be vesicular. This may be avoided by using charcoal; but with either fuel the bronze will be of uncertain composition. The Japanese method is in this respect decidedly faulty.

For castings of small or moderate size, the bronze should be melted in plumbago crucibles. For large castings requiring the contents of several crucibles, a vessel of sufficient capacity should be provided into which the metal from all the crucibles should be poured and then from it into the mould.

The bronze should not be stirred with iron rods, or it will be contaminated with iron, but with plumbago stirrers. This method should be adopted whenever practicable even for castings of considerable size, and the fuel used should be charcoal or specially-selected coke as free as possible from sulphur.

For colossal castings reverberatory furnaces must be used, and when worked with care they give satisfactory results. A point apt to be neglected in these furnaces is the proper mixing of the alloy—not a difficult matter, but requiring more supervision than is often given to it—and everyone who has had to make many castings with them will have occasionally found crusts of a white alloy attached to the sides of the hearth, indicating that some of the castings did not contain their full amount of tin.

A second point of importance which is often overlooked is the liability of the metal to absorb sulphurous anhydride (SO_2) from the products of combustion of the fuel. This may be prevented by keeping a sufficient supply of charcoal on the melting hearth whilst the copper is being melted, and afterwards a thick layer on its surface, and at the same time guarding against a large accumulation of ashes and clinker in the fireplace.

Another important point is the prevention of the formation of suboxide of copper (Cu_2O) during the melting of the copper before the addition of the tin and other metals, as whenever this is formed it dissolves in the copper and when the tin and zinc are added it reacts with them forming difficultly fusible oxides, which diminish very greatly the fluidity of the bronze.*

It is prevented, to a certain extent, by keeping an excess of charcoal on the melting hearth, but too often this is an insufficient precaution, and I would strongly recommend in all cases that the copper should be treated by the process known as "poling," before the addition of the tin and other metals. This is performed by placing the end of a pole of green wood below the surface of the copper; much gas and vapour are given off, the metal is violently agitated so that every particle is brought into contact with the charcoal on its surface, and all traces of suboxide are removed.

Phosphorus, aluminium, and manganese have each the effect of removing this oxide; they should not, however, be added in excess, but only in sufficient quantities to ensure this result. The kind of copper used is also of great importance.

The purest metal obtainable should alone be employed in the preparation of bronze for valuable "cera perduta" castings: electro-deposited copper if possible, or, at least, what is known as "best selected" copper, and this should have an electric conductivity of not less than 98 per cent. on Matthiessen's scale.

STAINS AND PATINAS.

The rich patinas which Japanese bronzes

* This can be easily demonstrated by melting a little copper in a crucible, allowing it to oxidise, and then adding zinc, when the resulting alloy will be found to be so pasty that it can hardly be poured out of the crucible.

acquire by age or special treatment and which enhance so much the beauty of the artists' work are worthy of a brief consideration, although perhaps they do not strictly come within the scope of the title of this paper. In many bronzes the beautiful colour is due merely to a "stain," *i.e.*, a coloured film of infinitesmal thinness. In others the surface of the metal is altered to a considerable depth, and in these only have we true patinas. Frequently both a "stain" and a patina are produced by similar treatment, but the operations required for the latter are of a more prolonged character than for the former, and are accompanied by special manipulations in addition to the application of what are termed pickling solutions. For the production of true patinas of the richest and darkest shades of brown by Japanese methods it is essential that lead should form one of the constituents of the bronze, and that zinc should either be absent altogether or be present only in small proportions. On the other hand, "stains" of any colour can be given to metal of any composition and even to unalloyed copper.

The substances used in the operations are—copper sulphate, basic acetates of copper (verdigris), iron sulphate, sulphur in fine powder, alum, vinegar prepared from unripe plums, and a decoction of the roots or entire plant of "Calamagrostis Hakonensis" (Nat. Ord. *Gramineæ*), potassium nitrate and sodium chloride. The most important of these reagents are the first five in the above enumeration. Various mixtures of these are dissolved or suspended in plum vinegar and water to form what are called the pickling solutions. Sometimes they are applied in the form of pastes. Some are also used singly to obtain special effects, especially the decoction of *Calamagrostis*. The proportions in which they are mixed to form the pickling solutions are different in every art foundry, even for the same patina. Hence several recipes—said to be used for special patinas—which have been communicated to foreigners, and in which these proportions are given in very exact weights, are not strictly representative of actual practice. So far as my observations go, the ingredients are never carefully weighed in making a solution, and when it is made, additional quantities are so often mixed with it at the discretion of the craftsman, that after the first day of its use it is impossible to say what its composition really is. Old solutions are always preferred to new, and in many cases are added to the new in large quantities, thus still further increasing the indefiniteness of their composition. In the bronze department of the Imperial Mint which was superintended by an old art-worker of great skill, there was only one pickling solution for the treatment of bronze. About equal parts of copper and iron sulphates and smaller quantities of alum and sulphur mixed with varying quantities of plum vinegar, water, and old solution, were used in its preparation. Almost every variety of stains and patinas—excepting red and green—were obtained by its use by varying the mode in which it was applied, and the treatment of the bronze between the applications.

The processes for producing a patina by the use of these solutions are, as might be expected from what I have just stated, neither simple nor easy, and the intermediate operations, on which its production depends more than on the exact composition of the solution, are so variously modified in different foundries that I can only give you an imperfect account of their chief features, within the limits of this paper.

When the casting has been freed from any adherent portion of the mould, its surface, where necessary, is very carefully smoothed by lightly rubbing it with a piece of soft close-grained charcoal, or with an impalpable powder of silicious shale prepared by levigation. After its surface has been thus prepared, it is sometimes boiled in a decoction of finely ground beans (*Glycine hispida*), this treatment being supposed to facilitate the action of the pickling solution.

It is then immersed in the pickling solution, which is frequently heated almost or quite to the boiling point, but sometimes to a much lower temperature. In other cases it is allowed to remain in a cold solution for many hours. After the casting has been acted on until the required effect of this stage of the process has been obtained it is taken out and washed with water, and also with a decoction of *Calamagrostis*. It is then carefully heated over a brazier containing burning charcoal, being turned round from time to time until every part has been brought to the proper temperature. During this operation it is frequently wetted with the above decoction or with a pickling solution; and the amount of time and patience bestowed on this manipulation is almost incredible. The casting is again submitted to the action of the pickle, again heated as above described, and these operations are repeated until the desired patina has been produced.

It is obvious that large bronzes cannot be thus treated. The pickling solution can only be applied to them in washes, and their action is thus merely sufficient to produce a very thin film of altered metal, scarcely, if at all, more than a stain, and the true patina only results from the action of time. A green patina, in imitation of that of ancient bronzes which have been exposed to the action of the weather, is obtained by treating the casting with plum vinegar, to which common salt is occasionally added, and exposing it to the air, and sometimes this is supplemented by burial in the ground for varying lengths of time. This patina, although often very beautiful, is, I need hardly say, of an entirely different character from the mixture of carbonates, oxychlorides, and oxides of which the true old patina consists.

It will be seen from the foregoing that much practice, careful observation, and patient labour are required for the successful performance of these operations. The artist has no definite rules for his guidance in carrying them out, each seems to have his own methods of procedure, and these he varies according to his experience. His success does not depend on the use of solutions of definite composition, or on the exact proportions of the metals in his alloys, but rather on his ability to correctly modify the manipulation of the various stages of the process, so that the patina he aims at may be infallibly produced. These are the chief features of what may be termed the "wet" method of producing patina. The oldest bronzes, however, owe their patinas almost exclusively to the action of time, and those of intermediate age generally to "dry" methods, in which they were exposed to carefully-regulated temperatures in furnaces heated by charcoal. These "dry" methods have now been almost entirely displaced by the "wet" methods just described, and were not in use in the foundries in Ozaka to which I had access, so that I have not seen them in operation. Several specimens of bronzes, with magnificent patinas, are exhibited, from the collections of my friends, Mr. Alfred Cock, Mr. Swan, and Mr. Tomkinson.

From the account I have just given you—I fear a very imperfect one—of the methods of casting bronze in Japan, it will be seen that they do not differ very greatly from ours. The chief differences lie in the use of the artist's model itself in the preparation of the mould, in the heating of the mould, and the composition of the bronze. All these we can imitate; but the special excellence of Japanese bronze castings—the faithful reproduction of the wax model, the comparative absence of retouching, the delicacy and vigour of the relief decoration—are not due solely to these, but are the results of a combination of conditions which are only of exceptional occurrence here. Chief among these is the nature of the Japanese people, the intense feeling and love of art with which they have been imbued for centuries past, and their just and enthusiastic appreciation of faithfulness in work. These qualities have made every workman an artist, hence the patient and marvellous skill which we see displayed in all his work, as well on common articles for everyday use as on those for the special purpose of decoration. The training which the artist receives in the operations of founding is also an important factor which cannot be overlooked. Besides these there is an *esprit-de-corps* in the staff of a Japanese art foundry—which is not always found in Europe—the outcome of which is that an amount of painstaking care, almost incredible, is exercised by all, so that the work shall be as perfect as they can make it and worthy of the renown of their master.

One word only in conclusion. I think it will be admitted by all that a sculptor should himself possess a practical knowledge of the technical processes by which his work is to be reproduced in bronze. Now, in this country this knowledge can only be acquired with the greatest difficulty by our artists as it does not form a part of any course of their art training. I would hence repeat and endorse, with the emphasis it deserves, the suggestion made by Mr. Simonds in a valuable paper on "Artistic Bronze Casting," read before this Society nine years ago, "that studios should be established in connection with our national art schools, where the student of sculpture could be practically taught the various processes incidental to his profession of moulding and bronze casting," and, I would add, the colouring of metals. It would seem to be a matter, in the encouragement and development of which our Society might be able to afford valuable aid. There should be no insuperable difficulties in carrying it out, and I am sure you will all agree with me that if it were carried out it could not fail to be of inestimable value to our artists, and to promote in no small degree the advancement of the art of bronze founding in our country.

The magnificent bronzes which I have the

privilege of exhibiting to you to-night are chiefly from the collection of my friends—Professor W. Anderson, Messrs. W. Cleverley Alexander, Alfred Cock, E. Dillon, F. Dillon, W. E. Hennell, Sir Trevor Lawrence, Messrs. R. Mills, Alfred Parsons, Charles H. Read, F. A. Satow, W. Harding Smith, R. Phene Spiers, J. M. Swan, H. V. Tebbs, and M. Tomkinson, to all of whom I desire here to express my sincere thanks for having so kindly lent them for the illustration of my paper, and especially so as I feel that any interest it may have had is largely due to them. I also owe many thanks to Monsieur Cernuschi for his kindness in permitting me to have photographs taken of the fine specimens in his unique collection, which I have shown you on the screen.

DISCUSSION.

The CHAIRMAN said it had been a great pleasure to him to listen to such an admirable paper from a gentleman who was at once an artist, an antiquary, and a metallurgist—a combination such as was rarely met with. Perhaps the most interesting portion of the paper to him was that which related to the production of patinas, and on that subject, as on several others, they would all have been glad to hear more. With regard to the conversion of coins into works of art, he believed complaints were made from time to time as to the amount of bronze that found its way into the offertories of London churches; but he thought, if they could feel certain that Mr. Alfred Gilbert, Mr. Simonds, or Mr. George Frampton would at once convert them into works of art, these offerings would be far more liberal than they were.

His Excellency the JAPANESE MINISTER said he had no pretensions to be a connoisseur in art, or to any knowledge on the subject of alloys. The only thing which struck him that evening, as on similar occasions when he had heard lectures on Japanese art, was that the people of England studied art, which to a Japanese was a novelty. They enjoyed art, and might perhaps be artists by nature, but they did not study it. In this country people classified objects, traced back dates, and investigated methods, but the Japanese simply contented themselves with enjoying fine art. Of course systematic study was essential to the advancement of science and art; but he thought Mr. Gowland would agree with him that the Japanese workmen, in mixing their compositions, simply tried and tried again, until they got what they wanted; that was the typical feature of Japanese art.

Mr. GEORGE SIMONDS said the paper was so complete, that it would be presumptuous to attempt to add anything to it. What interested them most in England was not so much the methods by which the Japanese cast their bronzes—which were practically almost identical with our own, so far as *cire perdu* work was concerned—but the way in which they produced their patinas, for that was a question of which we knew nothing. There was not a bronze founder in England who had any idea of producing a patina beyond the ordinary green. It was a most difficult thing to get a good patina. There was one man in London, named Lemon, who produced patinas of various colours, but they were not genuine patinas, they were simply painted on. They had nothing to do with the bronzes, and could easily be cleaned off. Mr. Gowland insisted very much on the use of lead in statuary bronze; and it might be interesting to know that lead had been used for such purposes for at least two centuries in Europe. Bouchardon's statue of Louis XV. contained lead, and the statue of Henri IV. on the Pont Neuf, which was quite a modern work, also contained lead. It had been the practice of a great many of the best bronze founders to add a little lead, because it not only made the metal flow more easily, but gave it a better colour. He had himself used as much as one ounce of lead to one pound of bronze.

Professor W. ANDERSON said he had not sufficient technical knowledge to add anything to the paper, but should be very glad if Mr. Gowland could afford any further information as to the composition of the metal and the methods of working.

Mr. GEORGE FRAMPTON A.R.A., suggested that the London County Council, out of the large funds at their disposal for the purposes of technical education, might import some artists from Japan to teach us their methods. He desired, as a sculptor, to thank Mr. Gowland most heartily for the most interesting evening he had ever had.

Mr. J. SPARKES said he must plead absolute ignorance of the technical limitations which beset every one who tried to cast in bronze. What little experience he had had, had been in observing the terrible failures made in England in the attempt to carry out the *cire perdu* process. He had seen figures most charmingly modelled come out without heads or minus their limbs. It was much the same in France, and although better success attended artists' efforts now than formerly, still he thought the suggestion of importing some Japanese workmen was well worth consideration.

Mr. J. M. SWAN, A.R.A., desired to thank Mr. Gowland for the most elaborate paper he had ever heard on the principles of bronze founding. Christofle, of Paris, had been working a long time at this subject, and he was told that there was one man who spent his whole time in colouring bronzes, and earned a very good living at it. With regard to this matter, he found that the colour of the patina

was relative to the alloy used, that the dull surface of the bronze was affected differently according to its composition, and also that the patina obtained by pickles was very much increased by time, but all relative to the action of the lead or zinc. He had seen ordinary bronze door hinges in England with a very beautiful patina, obtained by oxidation, similar to that obtained by means of cold pickling pastes, such as were used in Japan, and also in India. There was one patina—a kind of splashed vermilion, which he thought was due to the presence of mercury, but Mr. Gowland told him it was not—which it was the despair of any European to produce. There was also the lobster red, of which he had seen specimens, but utterly despaired of obtaining. If any sample of the *Calamagrostis* grass could be obtained, he should like to try the effect of a pickle made from it. They were much indebted to Mr. Gowland for the new alloy on a Japanese basis, which might be used by English founders. The method of mending defects in figures by casting upon them had been used in Italy and also in England.

Mr. Onslow Ford, A.R.A., said he had hoped to hear that the Japanese employed some preparation in their moulds which ensured perfect safety in the casting, and though he was disappointed in that, it was perhaps a little bit consoling to learn that they had accidents at times, as well as other people. Figures did certainly come out defective sometimes, but he did not think such accidents were now so common as formerly. *Cire perdu* casting was only ten years old in this country, but both Mr. Simonds and himself had practised it to some extent. It would be a very advantageous thing if it could be taught to the students, so that they might really know how to reproduce their work. He should like to ask if the clay used for the first covering of the mould was a fireclay, or partook more of the nature of a porcelain clay, and if there were any equivalent material in England.

Mr. W. F. Reid said he should like to ask one or two questions, and first, with regard to the burning together of the pieces of large statues, because English metallurgists found some difficulty in joining large pieces. With regard to the interesting illustrations given, and the method of smoking the sand moulds for the production of coins, he might say that a similar plan was followed in Birmingham, where the smoke from burning resin was used. He should like to ask why the metal was not run into the mould while it was embedded in the fuel, and at a red heat, which he had found to be the only means of getting very delicate castings. He had been able to construct a mould which gave the most delicate detail, such as the sting on a nettle leaf, or the pollen of a flower, but the great difficulty was to get the metal to fill the mould, and he could only do so by having the mould almost at the temperature of the molten metal. In connection with that, he made some observations which threw some light on the use of lead in these alloys. If you used a metal the oxides of which did not combine chemically with the material of the mould, the metal did not wet the mould in the same way that mercury would not wet glass or iron, but if you covered the iron with zinc. the mercury would wet it. Lead at a high temperature oxidised, and the oxide of lead formed a silicate with the siliceous mould, and then the alloy would run into the finest interstices, provided it were kept hot enough. He should also like to know what were the active constituents of the vegetable solutions used for pickling, and whether or not acetic acid was one of the chief constituents. Most of these pickling processes appeared to be based on the fact that the impurities in the copper were removed, leaving a film of copper, the different stages of oxidation of which would probably give different degrees of colour. We had much to learn from Japan in the arts of peace, and if they had learned something from us in the arts of war, they had amply repaid us.

Mr. G. A. Goodwin asked if the moulds were kept sufficiently hot to keep the liquid inside in a molten state, otherwise, when it was poured in in stages, he did not see how the metal first poured in was prevented solidifying before the rest was added, which would produce a mark in the casting?

Mr. Tookey said he had great difficulties for some time during his experience at the Imperial Mint in Japan, owing to the impurities in the copper which was introduced as an alloy into the gold coins. Even that from the Government copper works, where they used the liquation furnace, was melted with lead, in order to extract the silver from it; and the copper which was sent to the Mint from those works invariably contained a small quantity of lead. Though it was only sometimes in the second decimal place, it was quite sufficient to give a brittle alloy with standard gold; and when the bar was pinched in the rolls for the first time it split from the edge to the centre, so that not a single coin could be got out of it. Having discovered that this was due to the lead accidentally present in the copper, he requested the chemist or assayer who had charge of the refining of the copper to look into the matter, and ultimately a different method was adopted, and from that time there was no difficulty in producing the gold coins with as great facility as on Tower-hill. He had no experience with regard to bronze itself, his time being wholly occupied in the Mint.

The Chairman said he quite agreed with Mr. Swan that the composition of the metal had a vast influence on the nature of the patina. The most beautiful of all the purple ones, which Mr. Gowland had hardly been able to touch upon, was produced by the presence of about 2 per cent. of gold, and it was quite worth while to sacrifice a small amount of gold to produce so lovely an effect. This was the view

taken by the Japanese, who used a little gold simply for the sake of the colour it enabled the metal to assume when suitably treated with pickles.

Mr. GOWLAND regretted that time had not permitted him to read a fuller abstract, but several points on which information had been asked would be found fully explained in the paper. With reference to the statues mentioned by Mr. Simonds, both contained smaller quantities of lead (Louis XV., 3·15 per cent. of lead, Henri IV., ·48 per cent. of lead) than he proposed should be used, but the quantities which had been used by Mr. Simonds himself, closely approximated to those which he advocated. He thanked Mr. Swan very much for his valuable remarks on stains and patinas. The lobster red was due to the action of heat wholly. He hoped to receive some of the calamagrostis from Japan before long, and should be glad to supply any of his friends with samples, so that they might try the effect of it; and he hoped they would be as successful in using it as the Japanese. In answer to Mr. Onslow Ford, he would say that the Japanese had occasionally partial failures in their castings by the *cera perduta* method, yet they were by no means common; and he attributed their success to the careful manner in which they tempered their clays and prepared their moulds from them, and also to the proportion of lead present in their bronzes. The clays were the products of the decomposition of granitic rocks, and were really impure kaolin, containing considerable quantities of alkalies. They were not very refractory, and could not be termed fireclays. They possessed, however, extraordinary plasticity, and could be mixed with large quantities of sand without having that plasticity destroyed. Similar clays ought to be found in the granite districts in this country. The difficulties mentioned by Mr. Reid, which are encountered in England in burning together large pieces of colossal statues, were also found in Japanese practice, and in many cases the joints were imperfect. Mr. Reid asked why the metal was not run into the mould when it was imbedded in the fuel, and at a full red red heat. This was the first question he had asked himself when he first visited a Japanese foundry many years ago, and he was told that although this was frequently done in making thin iron castings, it could not be practised with karakane, as castings with burnt, rough, and irregular surfaces and of considerable brittleness were then produced. He had not determined the active constituents of the organic substances, viz.: plum vinegar and calamagrostis, used for producing patinas. In the former there are other organic acids present besides acetic acid. The latter had not yet been chemically examined. As the subject of patinas and stains appeared to be of special interest, he hoped to be able to deal with it in greater detail in a future paper. In answer to Mr. Goodwin's question, he might say that the moulds were only at a dull red heat when the metal was poured in, and the lower ingates were closed with clay stoppers and luting so quickly, that the workman pouring the metal were not delayed at all. In conclusion, he begged to thank heartily His Excellency and all who had taken part in the discussion for their valuable remarks and favourable criticism.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Gowland, which concluded the proceedings.

NINETEENTH ORDINARY MEETING.

Wednesday, May 1, 1895; Dr. W. ANDERSON, F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Richey, Sir James Bellett, K.C.I.E., C.S.I., Briers, Byfleet, Surrey.

Thompson, Robert William, Kotri-Rohri Railway, Rohri, Sind, India.

The following candidates were ballotted for and duly elected members of the Society.

Caink, Thomas, Woodland-view, London-road, Worcester.

Christison, George Watt, 28, Court-road, West Norwood, S.E.

Garrard, J. M., 25, Haymarket, S.W.

Gowan, Robert Anthony, National Liberal Club, Whitehall-place, S.W.

Hawkins, Rupert Skelton, Indian Midland Railway Company, District Superintendent's Office, Bina, India.

Hutchinson, Major-General George, C.B., C.S.I., Holmleigh, Mount-park-hill, Ealing, W.

Laurie, Edwin Hampden, 16, Blandford-square, N.W.

Walker, Ernest Mowbray, 101, Clarendon-road, Notting-hill, W.

Wilmer, Horace, South Woodford, Essex.

The paper read was—

DEVIATION OF THE COMPASS.

By PROF. A. W. REINOLD, F.R.S.

By the deviation of the compass we mean the angle by which the compass needle errs from the magnetic meridian, or from the direction of magnetic north. On shore there is no deviation, nor is there on board a ship made of wood or other non-magnetic material. But iron is a magnetic substance, and on board an iron ship the compass needle is liable to be deflected from the magnetic meridian. The action of the iron is twofold: (1) some of it becomes permanently magnetised during the

construction of the ship; (2) other is endowed with shifting magnetism, due to the changing position of the ship. The compass is affected by both causes, and there will generally be deviation; to what extent, and in what direction, depends upon a variety of conditions, *e.g.* (1) on the magnetic quality of the materials of the ship's structure; (2) on the latitude of the place where the ship was built; (3) on the position of the ship with regard to the magnetic meridian when building; (4) on the disposition of the iron in the ship; and (5) on the position of the compass.

Let me say at once that a magnetic needle or a compass card does not generally point exactly to the north. In London it points 17° to the west of true north, on the west coast of Ireland this angle is 23°, and in Greenland as much as 60°. In the Pacific Ocean, and in the western parts of North and South America, this variation, or magnetic declination as it is called, is easterly. At Vancouver, for instance, the compass needle points 26° to the east of true north. But these anomalies present no difficulty to the navigator, who knows from his charts the variation at the place where he is, and so from the compass course can at once determine the ship's true course.

A compass card is so balanced that it can only move on a horizontal plane; but that the earth's magnetic force is not entirely horizontal is shown by the fact that a magnet supported at its centre of gravity does not remain horizontal, but assumes a position in which its axis is inclined, in our latitude, at about 67° to the horizon. This angle is called the magnetic dip. The end of the magnet which points to the north is the end which is pulled down. We will call it the red end, or the red pole of the magnet; the other end, that which points towards the south, being called the blue end. The red pole of a magnet is that which is generally called its north pole, or its north-seeking pole, or, by Lord Kelvin, its true south pole; experience teaches us that it is better to avoid such terms, and to use neutral names, which do not involve any notion of north or south.

The experiment of the dipping magnet tells us that the earth's magnetic fall is partly horizontal and partly vertical; the dipping needle, being acted upon by these two components, takes up a position which is neither horizontal nor vertical, but, in London, inclined at 67° to the horizon, the red end being downwards.

Let me say a word about the materials of which iron ships are constructed. Prior to 1875, the hull of an iron ship—plates, ribs, beams, &c.—was made of wrought iron. Since 1875, mild steel, containing only about half per cent. carbon, has, to a large extent, supplanted wrought iron for the structural parts of ships, not only in the Royal Navy, but in the mercantile marine. From a magnetic point of view, mild steel and wrought or soft iron do not differ much from each other. Each is readily magnetised in a magnetic field, and under ordinary circumstances retains only a small part of its induced magnetism when the field is removed.

The cast steel used for the internal fittings of ships, and the nickel steel or other variety used for the armour plates of ships of war may be classed together as hard iron. The magnetic susceptibility is small, but magnetism once acquired by such material is not readily lost.

Manganese steel is a very interesting substance, both from a magnetic and also from a mechanical point of view, but, owing to its extreme hardness, it is not at present used in ship construction. It is practically non-magnetic.

[Experiments exhibited, illustrating the magtic susceptibility and retentiveness of mild steel, cast steel, and manganese steel.]

The apparatus which I have brought here for the illustration of our subject this evening consists of a skeleton binnacle, with the model of a ship's deck on the top. The whole can be turned about a vertical axis, the upper end of which is supported by a horizontal metal bar, with a recessed platform at the centre, which supports the compass. The binnacle is capable of carrying magnets and iron rods, horizontal and vertical, disposable in such a way as to imitate the magnetism of the ship and the various correctors. The compass consists of a small magnetised needle, attached at right angles to a glass stem, which carries a glass bulb and a mirror. The whole floats in water contained in a small glass cell. The stem has a small glass cup at the top, in which bears a steel point fastened to the lid. The buoyancy is such that the friction at the steel point is small. The advantages of the arrangement are (1) sensitiveness, (2) small friction, (3) no torsion, (4) considerable deadbeatness.

A bar of unmagnetised soft iron becomes a magnet when submitted to the action of the earth's field. The maximum effect is produced when the bar is parallel to the lines

of force in the earth's field, *i.e.*, parallel to the dip needle, but is nearly as great when the bar is held in a vertical position. The upper end acquires blue and the lower end red magnetism. [Experiment shown.]

The magnetism so acquired is only temporary, and disappears when the bar is held horizontal and perpendicular to the meridian. The bar is also magnetised temporarily when placed horizontal and in the meridian. [Experiments shown.] If the bar be again placed vertical and struck a few times with a mallet, the magnetism now acquired is greater than before, and is to some extent retained. [Experiment.]

Let the bar be now inverted. The end, A, which was before uppermost, and endowed with blue magnetism, part of which it retained, is now below, and has red magnetism induced in it by the vertical component of the earth's magnetism. The effect produced on the test needle is due to the difference between its retained blue and its temporarily acquired red magnetism. That the retained magnetism is not permanent is shown by striking the bar in its new position: its lower end becomes decidedly red. It may again be restored to the neutral or non-magnetised condition by a few blows when it is held horizontal and perpendicular to the meridian.

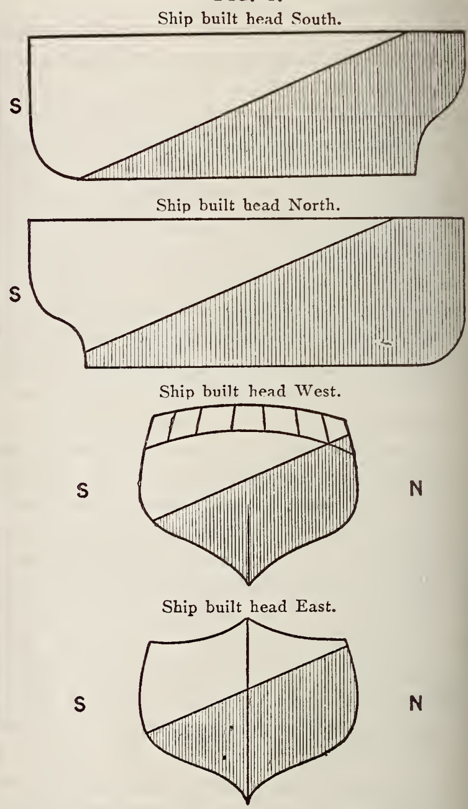
The effect of twisting an iron rod or wire in a magnetic field is similar to that due to percussion. But if the iron is soft, the acquired magnetism is soon got rid of. [Experiment.]

Suppose that similar experiments were made on a bar of hard iron, *i.e.*, on iron partaking more or less of the character of steel, we should find the inductive action of the earth decidedly less than in the case of soft iron or mild steel; the effect of hammering would not be so marked. But the magnetism acquired by hard iron when submitted to long continued and violent hammering, such as the plates of a ship receive when rivetted, &c., during the constructisn of a ship, is very difficult to shake out. A large proportion of it is practically permanent. It remains indefinitely, and could only be got rid of by submitting the iron to a more powerful magnetic field than that of the earth.

We thus see how a ship becomes a permanent magnet. Each plate, or rib, or beam, each bulkhead or watertight division remains in a fixed position while heavy blows are poured upon it. It must become a magnet, its upper parts and those towards the south acquiring blue, and its lower parts and those towards the north red magnetism. But a number of small magnets when joined together so that blue is always in contact with red and red with blue constitute one large magnet. Thus the iron ship becomes a huge magnet, one half of it being blue the other half red magnetism, the dividing plane being approximately perpendicular to the earth's lines of gravitation.

Fig. 1 shows the distribution of magnetism in ships with head N.S.E. and W. in our latitude.

FIG. 1.



PERMANENT MAGNETISM OF IRON SHIP.

The next experiment illustrates the effect of the permanent magnetism of an iron ship on the compass as the ship swings through a complete circle. The *error* is easterly during half the revolution and westerly during the other half. It is thus semicircular in its character.

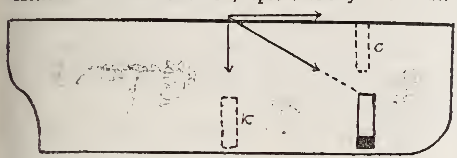
It is usual when an iron ship is launched and brought into the basin where she is to be finished and equipped, to place her in a position directly opposite to that which she occupied on the building slip. If, for instance, she lay north and south with head north, she is now placed north and south with head south. Her loose magnetism is thus during the second

period of construction to a large extent knocked out of her, and a ship so treated settles down into a permanent state as regards her magnetism more quickly than one in which this precaution has been omitted.

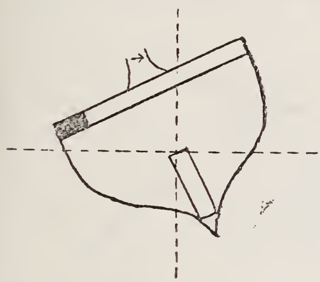
I spoke of the effect of an iron ship on a compass on board as being two-fold, viz., that due to the permanent magnetism of the ship, and that due to temporary induction in soft iron. We have now to consider the second of these, and in doing so we will take in order the action of the vertical and horizontal components

FIG. 2.

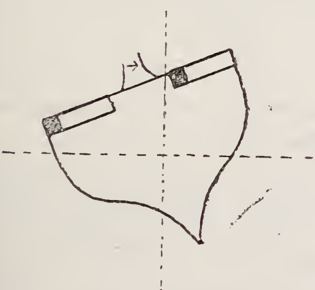
Action of Vertical Iron Rod, represented by Two Rods.



Continuous Beam. Error to Windward.



Detached Masses Port and Starboard. Error to Leeward.



HEELING ERROR.

of the earth's magnetism. Every vertical mass of iron in the ship—the ship's sides and ribs, fore and aft and transverse compartment divisions, masts, funnels, &c., will be magnetised with (in these latitudes) blue polarity at the top and red at the bottom. If all the iron is symmetrically disposed with regard to a central vertical fore and aft plane, it may, so far as its action on the compass is concerned, be supposed to be replaced by a single vertical rod with one of its extremities in the fore and aft line through the compass (Fig. 2); whether this imaginary resultant rod is foreward or aft of the compass will depend upon where the compass itself is placed on the ship.

The effect on the compass of all the vertical iron is then the same as that of a single vertical iron rod in the fore and aft line through the compass. As the ship swings completely round this will produce an error of precisely the same character as that we have already considered, viz., semicircular. [Experiment shown.] The force with which the vertical iron acts upon the compass is constant and independent of the direction of the ship's head, but it changes when the ship changes her magnetic latitude. At the magnetic equator there is no vertical force; and thus vertical iron, which in London might produce a large compass error, would on the equator have no influence. As the ship proceeds farther south, the error due to vertical iron would reappear, but with changed sign, since, in the southern hemisphere, a vertical iron rod will have red polarity at the top. On the other hand, the error due to the permanent magnetism of the ship is the same in all parts of the world, if we may assume that the vessel has settled down into a constant state as regards her magnetism. It will be desirable to bear these facts in mind when we come to consider the compensation of compass errors.

The next point to consider is the action on the compass of magnetism induced in the iron of the ship by the horizontal component of the earth's magnetism.

There is ordinarily a large mass of soft iron in a ship in which horizontal induction can take place, *e.g.*, iron decks, the sides, and cross-beams, engines, boilers, &c.; but whatever its disposition, provided it be symmetrical with regard to the fore and aft line, its resultant effect on the compass may be considered as due to, and may be represented by, iron rods, in the plane of the compass, and in the fore and aft and transverse lines through the centre of the compass. Such rods will produce no compass error when the ship is magnetic north and south, or magnetic east and west. But in intermediate positions the induced magnetism will deflect the needle, and a little consideration will show that if the error is easterly, when the ship's head is in the north-east quadrant, it will also be easterly when the ship's head is in the south-west quadrant, and will be westerly in the other two quadrants.

This error is called quadrantal, because it changes sign in every quadrant. If easterly

with the ship's head in the north-east quadrant, it is said to be positive. [Experiment shown.] Fig. 3 shows that isolated rods in the fore and aft line produce positive, and in the athwartship line negative quadrantal error. This suggests a mode of correcting the error by employing masses of iron, generally spheres, tolerably close to the compass. If the error is positive, the spheres must be placed port and starboard of the compass: if negative, in the fore and aft line. In ships of the Royal Navy, and generally in the large majority of cases, the error is positive, and the correcting quadrantal spheres are supported on brackets at suitable distances on the port and starboard sides of the compass.

We have supposed the iron of the ship to be symmetrically arranged with respect to the fore and aft vertical plane through the compass, and though this is generally the case, it is not necessarily so. There may be a mass of iron, say an iron pinnace or launch stowed on one side of a ship in the neighbourhood of the compass, not balanced by an equal mass on the other side. In some of our turretted battleships the turrets are arranged skewwise, each having a free fore and aft fire. Such unsymmetrically-disposed iron gives rise to a quadrantal error, which is a maximum at the cardinal points; and sometimes also to a small constant error, *i.e.*, one whose magnitude and sign are independent of the direction of the ship's head. The effect in question may be illustrated in the model by placing in the binnacle a rod of iron inclined at an angle of about 45° to the ship's fore and aft line. [Experiment shown.]

We have thus brought under view the various causes producing compass error on board an iron ship. They are summed up in the formula—

$\delta = A + B\sin\alpha + C\cos\alpha + D\sin 2\alpha + E\cos 2\alpha$,

δ = Deviation on any compass azimuth α measured from N. (by compass).

A, B, C, D, E are the coefficients—each is expressed in degrees of arc.

A is constant, depending on unsymmetrically placed iron.

B and C are components of the semicircular error, B resulting from fore and aft magnetic forces, C from transverse.

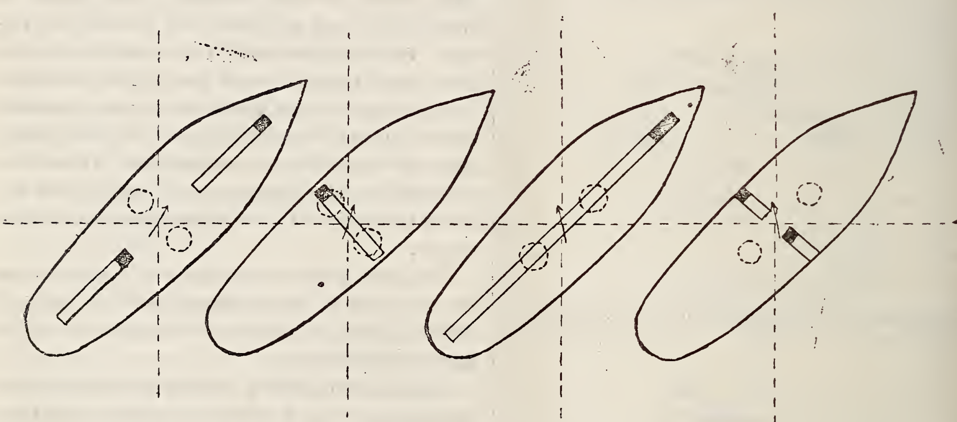
D and E are components of the quadrantal error: D due to symmetrical, E to unsymmetrical iron.

A and E may generally be neglected.

The method of compensation now universally adopted was first employed in a systematic manner by the late Sir George Airy, and has been brought to its present state of efficiency by Lord Kelvin. The formula shows us that there are only three components of the error with which we have generally to deal, viz., B, C, and D, B and C referring to semicircular and D to quadrantal error. B arises from fore and aft magnetic forces, due to vertical iron and permanent magnetism of ship; C from transverse forces, due to permanent magnetism only.

The component C can be corrected by permanent steel magnets, placed in the binnacle at a suitable depth below the compass, with blue poles to starboard if the error is to port, and *vice-versâ*. Similarly B, if it were due to the permanent magnetism of the ship only, *i.e.*, if induction in vertical iron had no part in producing it, might be corrected by

Fig. 3.



Easterly Error, corrected by spheres in athwartship line. | Westerly Error, corrected by spheres in fore and aft line.

Induction in Horizontal Iron. (Ship's head in N.E. quadrant.)

fore and aft magnets suitably placed in the binnacle. But if part of B is due to vertical iron, that part ought to be corrected by vertical iron, and the remainder only by magnets. The difficulty is to know how much of the observed error is due to each of the above causes, and this one cannot know until observations have been taken in two widely different latitudes. On the magnetic equator there is no vertical force, and therefore the whole of B observed on the magnetic equator must be due to permanent magnetism, and should be corrected by steel magnets. If on board such a ship, sailing northwards from the equator, B should be found to have a sensible and increasing value, we should know that it was due to vertical induction only, and we should correct it by vertical induction, *i.e.*, by placing a vertical rod of iron of suitable length, close to the binnacle, either forward or aft of it, so that its effect should just balance that of all the vertical iron of the ship. Such a rod is called a Flinders bar. As used in Lord Kelvin's binnacle, it is 24 inches long and 3 inches in diameter, and is made up of pieces, the longest of which is 12 inches long, and the shortest $\frac{3}{4}$ of an inch. Thus, within limits, any error due to vertical induction may be corrected by taking a suitable length of Flinders bar. [Correction of semicircular error illustrated experimentally.]

We have thus by permanent magnets, Flinders bar, and the quadrantal spheres balanced every cause of compass error, and the compensation thus effected will hold good for all latitudes, so long as the ship remains on an even keel. But although the compass shows no error with the ship upright, this will not generally be the case when the ship heels. In the latter case, the symmetrical arrangement of iron and correctors, with regard to the compass, will be disturbed. Horizontal iron becomes inclined, and is magnetised by the earth's vertical force. Forces which previously acted vertically downwards or upwards, have now a horizontal component; so that when an iron ship heels we may generally expect the compass to be affected, though there is no error when she is on an even keel. Let me briefly refer to the causes of heeling error, and then endeavour to illustrate them experimentally.

Fig. 2 illustrates this part of the subject. It shows that in the case of a continuous transverse beam the result of inclining the ship is to produce an error to the higher side of the ship or to windward. Isolated masses, port and starboard of the compass, produce an error to leeward. Vertical iron beneath the compass, producing a downward force, will give rise, when the ship heels, to an error to windward. Whether the vertical force due to the permanent magnetism of the ship is upwards or downwards will depend upon where the compass is placed. If it be not too near to bow or stern, and fairly high with regard to the general structure, the pull will be downwards and the heeling error to windward. We will now illustrate some of these statements experimentally.

I have here a model of a section of a ship which can be inclined, the small platform on which the compass is placed being fixed. Masses of iron may be placed port or starboard of the compass, or a continuous bar from one side to the other, or a vertical rod beneath the compass.

The Table (p. 864) exhibits in a tabular form the principal and secondary causes of heeling error, the direction of the error in each case, the direction of the ship's head when the error is a maximum and the mode of compensation. We will not here trouble ourselves about the subsidiary causes, but in the case of the others, it is clear (1) that generally the error is to windward; (2) that it is a maximum, when the ship lies north and south, and vanishes in the east and west direction. Next, with regard to compensation. Errors 1 and 2 are caused by vertical induction in iron, and should be similarly compensated. And to a certain extent they are so; for consider the iron spheres which correct the quadrantal error. These would by themselves produce a heeling error to leeward, and therefore act against the other causes. The amount of negative error produced (or positive error compensated) may be calculated when the size of the spheres and their distance from the compass are known, and the value so deduced agrees fairly well with that experimentally observed. The spheres correct from five to seven minutes of heeling error, per degree of heel, for each degree of quadrantal error they correct. Thus, suppose the quadrantal error to be 11°, the $8\frac{1}{2}$-inch spheres by which this is connected would by themselves produce a heeling error to leeward of about one degree (per degree of heel), and will therefore correct an error of one degree to windward.

The remainder of the error—which may be the principal part—is corrected by permanent magnets, one, two, or three in number, placed

HEELING ERROR. (STANDARD COMPASS.)

Ship built in Great Britain and heeling (in N. latitudes) to Starboard.

Causes.	Symbol.	Direction of Error.	Error a Maximum.	How Compensated.
Principal.				
1. Tranverse horizontal beams becoming inclined. Induction by earth's vertical force	e	To windward	When ship's head is North or S., varies as cos α α being azimuth of ship's head measured from North by compass	Partly by "Quadrantal" spheres.
2. Iron perpendicular to deck vertically below compass.	k	To windward	North or S.	By magnet or magnets, red poles upwards (generally) placed vertically in binnacle below compass.
3. Force perpendicular to deck due to ship's permanent magnetism	R	To windward (generally)	North or S.	
Subsidiary.				
4. Iron perpendicular deck *not* vertically below compass	c	To East	East or W. varies as $\sin^2 \alpha$	Flinders bar.
5. Horizontal fore and aft iron	g	To West if compass is near stern of ship: to East if compass near bow	N. or S. varies as $\cos^2 \alpha$	Compensation not generally attempted.

in a brass tube which can slide up and down a vertical central channel in the binnacle. The empirical method of correcting the error, and at first sight the simplest, would be, assuming there is no error on an even keel, to place the ship N. and S., cause and maintain a certain heel (say to starboard) of 10°, place magnets with red poles upwards in the receptacle provided for them, and raise or lower them until the error disappears; but owing to the difficulty and expense—especially with large ships—of actually heeling the ship, this method is not employed. One of the plans generally adopted—the simplest of them—is to determine the vertical magnetic force on shore by means of a suitable dip needle. The latter is then brought on board, placed in the binnacle (the compass bowl having been removed), so that the dip needle occupies the same position as the compass needle. The vertical correcting magnets are then raised or lowered until the vertical force on board is equal to that on shore, modified by the application of a small correction on account of the screening action of the iron of the ship. The dip needle has a sliding weight attached to it. This, in the experiment on shore, is moved until the needle is horizontal; in this case the mechanical couple, due to the earth's vertical force, is balanced by the leverage of the sliding weight. On board, the vertical magnets are moved until the horizontal position of the needle, which will probably have been disturbed, has been restored. The error is now corrected.

Although in the case of modern ships the angle of maintained heel is less than it used to be when ships trusted more to their sails, the correction of the heeling error has become of greater importance then formerly, owing to the fact that the compass error per degree of heel has—in ships of the Royal Navy at least—greatly increased. The standard compass is frequently placed immediately over the Conning tower, a massive structure having walls of iron a foot thick. The magnetism induced in this by the earth's vertical magnetic force produces no compass error so long as the ship is upright, but gives rises to an important horizontal component, producing error when the ship heels.

In the method of correcting the semi-circular and quadrantal errors of the compass, which so far described, it is necessary that the true magnetic bearing of some object visible from the ship should be known, so that the ship may be placed successively magnetic north and south, and magnetic east and west. It is possible, however, to completely correct the compass, when nothing is visible outside the ship, *e.g.*, in a fog or at night. The correction is effected by means of an instrument called a deflector. The principle of the method will be understood from the following considerations. Suppose the ship's magnetism to be such as can be represented by a blue pole in the bow; when the ship lies north and south there will be no compass error, but the directive force will be different when the ship is head north or head south. In the former

se it will be the sum of the earth's force and e ship's force; in the latter case, the differ-ice. If we can place fore and aft magnets the binnacle, to make the directive forces qual, we shall have abolished the fore and aft omponent of the semicircular error.

Similarly, if the ship's magnetism were such s to be represented by a blue pole on the arboard side of the compass, we could, by uitably placed athwartship magnets in the innacle, equalise the directive forces, ship's ead west and ship's head east, and so et rid of the transverse component. This s what the deflector enables us to do. On the table are two forms of the instru-nent, one Lord Kelvin's, consisting of two nagnets, hinged together at their extremities he free ends being adjustable, at a greater or less distance apart. The other form has been designed by Dr. Waghorn, Assistant-Professor of Physics at the Royal Naval College, Greenwich. It consists of two short parallel magnets, moveable up and down a vertical stem by a rack and pinion arrange-nent. (See Figs. 4 and 5.)

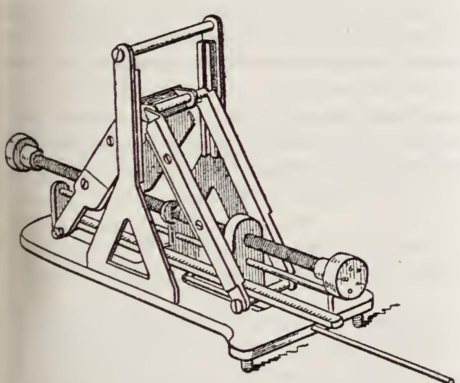


FIG. 4.—LORD KELVIN'S DEFLECTOR.

The mode of procedure is as follows:—Put the ship's head north by compass, and keep her there by means of an auxiliary compass. Place the deflector on the glass cover of the compass bowl, and arrange it so that the compass card is turned round through 90°. Lord Kelvin keeps his instrument in a fixed position on the bowl, and adjusts by altering the distance between the poles of the deflector magnets; this can readily be done by means of a double screw. Dr. Waghorn, on the other hand, rotates his deflector, without altering the position of the magnets on it, until the deflection of 90° is obtained, and reads off the angle (say α) the deflector makes with the compass needles,. Similar experiments are made with the ship's head south by compass, and another angle, β, is read off. The deflector is now set on an angle whose sine is the mean of the sines of α and β, and fore and aft magnets introduced into the binnacle until the deflection of the card is again 90°. The fore and aft component of the semicircular error—so far as it is due to permanent magnetism only—is now compensated. In an exactly similar way, by taking observations with the ship's head successively east and west by compass, the transverse component can be corrected.

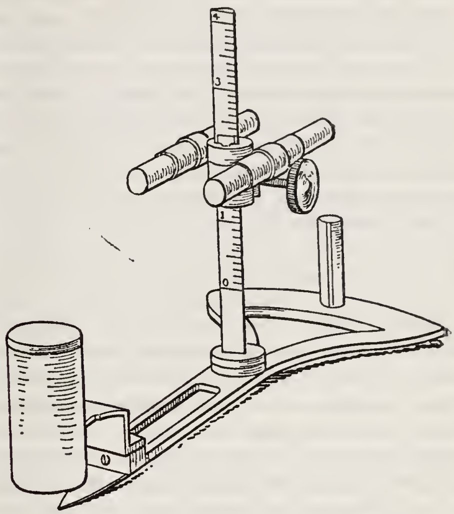


FIG. 5.—DR. WAGHORN'S DEFLECTOR.

I should weary you if I were to go into greater detail. I will only say that the use of these instruments, though requiring care and patience, is not by any means difficult, and is soon learnt. Further, by the deflector, it is possible, without disturbing or altering any correctors in the binnacle, to determine the coefficients, B, and C, and so to supply the means of computing the error on any compass course. This use of the deflector may be valuable in cases where it is undesirable to interfere with the correctors.

DISCUSSION.

Capt. CREAK, R.N., F.R.S., said Prof. Reinold had given a very full and lucid account of what occurred with a ship which was built of both hard and soft iron; but, unfortunately, in these days, there was in many ships an intermediate kind of iron, in which was produced what had been called sub-permanent magnetism by some, and by the Board of Trade officials retentive magnetism. That which was taken up by a ship lying for some time in one position, and was reversed

by turning her in the opposite direction, could hardly be called retentive; but sub-permanent magnetism as explained by Sir George Airy, was that which was taken up by a ship lying a certain time in one position, but which was lost on reversing her; it was permanent for a time, but was lost either by reversing the ship's position, or by gun-firing, or other violent action. It was the deviation produced by this cause which was most difficult to correct, and he had asked Lord Kelvin and others, but could get no suggestion how to do so. The *Lucania*, when she started for New York, had her com passes properly adjusted, but when she reached there, they were 10° out, when she turned north, and by the time she got back, they were 10° wrong the other way. On another point he was not quite in accord with Prof. Reinold. He said when a ship got to the magnetic equator, whatever magnetism she had would be permanent, and should be corrected by magnets. Now he had had the examination of the deviation of her Majesty's ships for many years, and some had been sent specially for experiment; and he found that when they arrived at the magnetic equator, before the Flinders bar could be adjusted properly, the ship had to be sent south, and then brought back north. Of course it could be done tentatively, and in the "Admiralty Manual," lately revised by himself, there was a table showing the length of bar that could be tentatively placed on arriving at the magnetic equator by means of an easy formula. Then, on going south, if you found more error coming in, due to soft iron, you could see by the table how many more inches of bar to put in. A very good instance for finding the length of bar was that of a ship going to the Cape, and then on to Bombay or Hong Kong. This would eliminate the effects due to sub-permanent magnetism. The correction for quadrantal and semicircular errors was perfectly easy, but the sub-permanent magnetism taken up by a ship from running on one course, or lying in a certain direction for a number of days, was a thing very difficult to deal with. The *Thunderer*, a ship fitted with a thin iron structure, had her compass made perfectly correct, but immediately after firing took up sub-permanent magnetism, when it was found wrong 4° on the north and 4° on the east point. This did not occur so much now, because the thin iron superstructures was more or less abolished, and one had to contend principally with the errors caused by heavy masses, like the Conning towers, and the whole body of the ship.

Captain ANTHONY THOMSON said there were two points on which he should like to have Prof. Reinold's opinion. One cause of deviation to which attention was not generally paid was the alteration in the trim of the ship, so that she drew more water fore and aft than when the compasses were adjusted. In the case of the *Thunderer*, he noticed that during a voyage when her trim altered, owing to the coals being burned out, the difference was as much as 3° or 4°; and on board his own ship, where the variation of trim was excessive, he found the difference still greater. The other point was the position of the magnets in the compass. They had heard of fixed magnets, and of those which kept their relative position to the compass when the ship rolled. In the latter case they would have a different effect on the compass card, because they remained horizontal, whilst the fixed magnets moved with the ship. The system of letting the magnets swing with the compass was much advocated by some, and possibly it had some advantages, and he should like to hear Professor Reinold's opinion about it.

The CHAIRMAN said he knew very little about this subject, but should like to know whether the difference between iron and steel was very marked. They knew that steel retained its magnetism, while soft iron did not, and with a combination of iron and steel there would be a certain amount of permanent magnetism remaining, dependent probably on the proportion of carbon in the steel. He did not know whether it was the carbon in the steel which gave it the property of retaining its magnetism; but the only way of defining the nature of steel was by the proportion of carbon it contained. He remembered, in his father's workshop at St. Petersburg, the files that used to hang on the wall became permanently magnetic, which was very annoying, because the iron or steel filings adhered to them and spoiled the work, unless constantly cleaned off. Probably the dip of the needle was greater there than in England. He could easily understand that an iron structure like a ship, if kept in one position for a certain time, would acquire a magnetism, which would be changed on the position being reversed.

Captain CREAK said steel ships were just as permanently magnetised as the old iron ships.

Professor REINOLD, in reply, said no iron was perfectly soft, and none was perfectly hard. Any given specimen partook of the character of both kinds. Even hard iron, which was permanently magnetised, on being placed in a magnetic field, took up further magnetism, which it lost again on removal. You could superimpose on the permanent magnetism of iron or steel some temporary magnetism, but the amount temporarily acquired and lost again by soft iron was much greater than that gained and lost by hard steel. Again, even the old ships, with soft iron hulls, had a considerable amount of permanent magnetism. He could not give much information on the question asked by the Chairman, but he did not think the magnetic character of iron or steel was a direct function of the quantity of carbon contained. Two steels that differed from each other in the proportion of carbon did not always differ in the same direction with regard to magnetism. If files were made of manganese steel there would be no fear of iron filings adhering to them under any circumstances. He did not like the word sub-permanent,

nd never used it if he could help it, because it had been used in different senses by different writers; even in the writings of Sir George Airy you would have to consider carefully what he meant by it. What Captain Creak had described as sub-permanent magnetism would be called by many as magnetic hysteresis, it seemed to depend on the lagging behind of the magnetism produced in a piece of iron in a magnetic field, as compared with the magnetism of the field itself. The iron did not at once take up the full magnetism corresponding to the field, and similarly it did not at once lose it when removed; it lagged behind. He knew nothing of the system of swinging the corrector magnets, but should not think it would work, because when a ship altered in any way the magnetic system of which she consisted turned round in a certain way with regard to the compass, and the correctors must turn in the same way if they were to be effective.

The CHAIRMAN then proposed a vote of thanks to Professor Reinold, which was carried unanimously,

Professor REINOLD, in responding, said the thanks of the meeting were also due to Mr. Haddon, who had so ably assisted with the experiments.

Notes on Books.

A TEXT-BOOK OF ORGANIC CHEMISTRY. By A. Bernthsen, Ph.D., translated by George M'Gowan, Ph.D. London: Blackie and Son. 1894.

This is the second English edition of Bernsthen's text-book. It is essentially a systematic outline of the chemistry of the carbon compounds, well adapted to the use of students who have already acquired some knowledge, especially some practical knowledge of the subject. The pages, some six hundred, are so well filled with information about the relations and interactions of the various compounds with one another that but little space is possible for detailed descriptions of methods of manufacture. It has clearly been the author's intention to furnish a concise summary of organic chemistry in a form which will give a fairly complete survey of the present state of the science. The introduction deals with the chemical and physical methods used for determining the atomic and molecular composition of carbon compounds. The various kinds of isomerism are explained, special attention being paid to the best known views on the cases of isomerism which can, at present, only be represented by modifications in three dimensional formulæ. The plan of classification which the author has adopted is the general one of taking first the hydrocarbons of the fatty series with their main derivatives, proceeding from these through bodies formed on a tetra-carbon nucleus (the furfurane and allied compounds), by a natural transition to the benzene or aromatic groups. Near the end of the book come the alkaloids, followed by a brief outline of the chemistry of the terpenes, camphors, resins, and glucosides, and the book finishes with a small chapter on albuminous substances and animal chemistry. Except for a few outline drawings of tetrahedra used in reference to stereo-isomerism there are no illustrations. The interest is decidedly of a theoretical character. At the same time the chief methods of formation, though treated in bare outline, are separately given with all the typical groups of compounds. The more advanced student who wishes to review his knowledge should find this work with its large amount of systematic information most useful. His reading will be facilitated by the continued use which has been made of cross references, an excellent feature of the book. It is doubtful whether a beginner would benefit by it. If he were intelligent enough to thoroughly master its contents and to follow the author's inductive methods of reasoning, he would require careful guidance in the practical branch of the subject to prevent his developing into a study-table chemist. The translation has evidently been carried out with great care, the meaning is always clear and unambiguous.

PROBLEMS AND SOLUTIONS IN ELEMENTARY ELECTRICITY AND MAGNETISM. By. W. Slingo and A. Brooker. London: Longmans, Green, and Co. 1895.

The book consists of a collection of examination questions, either selected from the South Kensington papers, or at all events similar to those set in the Science and Art Department examinations, with the answers. There can be little doubt that any student who could answer the questions given in the manner of the solutions also given, could also answer the questions of an actual examination paper and could therefore pass, which, it may be taken for granted, is the end to be attained.

AMMONIA REFRIGERATION. By Iltyd I. Redwood. New York: Spon and Chamberlain. London: Spon. 1895.

A handbook of information, tables, &c., intended for the use of engineers having charge of ammonia compressing machines for the production of low temperatures. The increased and increasing use of machinery of this character ought to make a demand for such information as the book is intended to supply.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

MAY 8.—"The Extraction of the Rarer Metals from their Oxides." By PROFESSOR WILLIAM CHANDLER ROBERTS-AUSTEN, C.B., F.R.S. JOHN WOLFE BARRY, C.B., Member of Council, will preside.

INDIAN SECTION.

Thursday Afternoons, at Half-past Four o'clock:—

MAY 23.—"Punjab Irrigation: Ancient and Modern." By SIR JAMES BROADWOOD LYALL, G.C.I.E., K.C.S.I., late Lieutenant-Governor of the Punjab.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 21.—"Commercial Education in Belgium." By PROFESSOR WILLIAM LAYTON. LORD REAY, G.C.S.I., G.C.I.E., will preside.

APPLIED ART SECTION.

Tuesdays:—

MAY 7.—"Recent Improvements in Designing, Colouring, and Manufacture of British Silk." By THOMAS WARDLE. H.R.H. THE PRINCESS MARY DUCHESS OF TECK will preside. [This meeting will be held at Four p.m.]

MAY 28.—"The Decoration of St. Paul's." By PROF. W. B. RICHMOND, A.R.A. THE VERY REV. THE DEAN OF ST. PAUL'S will preside. 8 p.m.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

JAMES DOUGLAS, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures.

LECTURE III.—MAY 6.—*The Metallurgy of Copper.*—Copper refineries of the Eastern States—Smelters at the mines—Melting and refining of lake mineral in ore operation—The reduction of oxydised ores in cupola furnaces—Water jacketted furnaces—Smelting works of the Anaconda Co.—Smelting works of the Boston and Montana Co. at Great Falls—Bessemerising of copper mattes at the Parrott works, Butte, and progress of the pneumatic method of matte concentration—Pyritic smelting—Effect of hot blast on coke consumption in the cupola—Hydro-metallurgy of copper in the United States.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 6 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. James Douglas, "Recent American Methods and Appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." (Lecture III.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Town-hall, Westminster, S.W., 8½ p.m. Mr. Charles Mason, "Street Subways for Large Towns."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. C. C. Hutchinson, "The Use of Hot Air in Drying." 2. Mr. A. Cameron, "The Estimation of Alkaline Salts in Fire Clays, Manures, &c."

British Architects, 9, Conduit-street, W., 8 p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Paper by Sir J. W. Dawson.

TUESDAY, MAY 7 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. (Applied Art Section.) Thomas Wardle, "Recent Improvements in Designing, Colouring, and the Manufacture of British Silks."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. George Forbes, "Alternating and Interrupted Electric Currents." (Lecture III.)

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Lieut.-Col. H. H. Godwin-Austen, "Lists and Distribution of the Land-Mollusca of the Andaman and Nicobar Group of Islands in the Bay of Bengal, with Descriptions of some supposed New Species." 2. Mr. F. E. Beddard and Mr. P. Chalmers Mitchell, "The Heart of the Alligator." 3. Mr. P. Chalmers Mitchell, "The Anatomy of *Chauna chavaria*." 4. Rev. W. J. Holland, "A Synonymic Catalogue of the *Hesperiidæ* of Africa and the adjacent Islands, with a Description of some apparently new Species."

Asiatic, 22, Albemarle-street, W., 4 p.m.

WEDNESDAY, MAY 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. William Chandler Roberts-Austen, "The Extraction of the Rarer Metals from their Oxides."

Geological, Burlington-house, W., 8 p.m.

Japan Society, 20, Hanover-square, W., 8½ p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, MAY 9...Iron and Steel Institute (at the HOUSE OF THE SOCIETY OF ARTS). Annual Meeting, 10½ a.m. 1. Mr. Arthur Cooper, "Metal Mixers, as used at the Works of the North-Eastern Steel Company, Limited. 2. Mr. H. M. Howe, "The Hardening of Steel." 3. Mr. W. J. Keep, "Tests of Cast Iron." 4. Mr. Sergius Kern, "The Manufacture of Steel Projectiles in Russia." 5. Mr. Herbert Scott, "The Iron Ore Mines of Elba." 6. Mr. J. E. Stead, "The Effect of Arsenic upon Steel."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Liquefaction of Gases."

Electrical Engineers (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Mr. Mark H. Robinson, "The Recent Development of the Single Acting High Speed Engine for Central Station Work."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MAY 10...Iron and Steel Institute (at the HOUSE OF THE SOCIETY OF ARTS). Annual Meeting, 10½ a.m. Reading of Paper and discussion continued.

United Service Institution, Whitehall-yard, 3 p.m. Commander Caborne, "The Royal Naval Reserves."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Hon. G. N. Curzon, "A Recent Journey in Afghanistan."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science Schools, South Kensington, S W. 1. Mr. E. F. Herroun, "The Iodine Voltometer." 2. Mr. A. Sharp, "A New Method in Harmonic Analysis."

SATURDAY, MAY 11...Sanitary Institute, 74A, Margaret-street, W., 2 p.m. Prof. Wynter Blyth, "Diseases of Animals in Relation to Meat Supply."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Arnold Dolmetsch, "Music and Musical Instruments of the 16th, 17th, and 18th Centuries." (Lecture III.)

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ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRACTICAL EXAMINATION IN MUSIC.

The Practical Examinations in Vocal and nstrumental Music will be conducted by Mr. ohn Farmer, Balliol College, Oxford, and Director of the Harrow Music School, and Mr. Ernest Walker, M.A., Mus. Bac., at the House of the Society, and will commence on Monday, the 17th June.

Particulars can be obtained on application o the Secretary.

CANTOR LECTURES.

On Monday evening, 6th inst., Mr. James Douglas delivered the third lecture of his course on "Recent American Methods and Appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver," in which he treated specially on the metallurgy of copper.

The lectures will be printed in the *Journal* during the summer recess.

APPLIED ART SECTION.

Thursday afternoon, May 7; H.R.H. the Princess Mary Adelaide, Duchess of Teck, in the chair. The paper read was on "The Improvements in the Designing, Colouring, and Manufacture of British Silks since the Egerton Exhibition of 1890," by Mr. Thomas Wardle.

The paper will be published in a later number of the *Journal*.

Proceedings of the Society.

INDIAN SECTION.

Thursday, April 25, 1895; Sir Albert K. Rollit, M.P., LL.D., Vice-President of the Society, in the chair.

The paper read was—

THE COMING RAILWAYS OF INDIA AND THEIR PROSPECTS.

By J. W. Parry, Assoc.M.I.C.E.,
Late Executive Engineer Indian State Railway.

I propose to divide the subject matter into—(A) First-class investments; (B) sound second-class investments; (C) other railways which will be required later on to develop India's resources. I shall then review the general prosperity of India, the particular prosperity of her railways at the present moment, and shall conclude with some remarks as to the financial aspects of the question, or how I propose to raise funds for constructing railways which are much needed and which have been unnecessarily delayed. I shall also add a suggestion for the Director-General of Railways, hoping that in future administration reports he will kindly give us the information we require.

(A) First-class Investments.

By first-class investments I mean such railways as will, when completed, at once begin to give a good return for the money invested, and whose prospects are extremely good—in fact, they might be called gilt-edged securities; in this class I include—

1. The Wazirabad-Multan Railway.
2. The Delhi-Minchinabad-Bahwalpur and Rohri-Kotri Railways.
3. The Rai-Bareli-Benares Railway.
4. The Rutlam-Muttra and Rutlam-Ujain Railways.

1. *The Wazirabad-Multan Railway.*—This is a chord line from Peshawur to Karachi, cutting off the Lahore corner. It is 200 miles long, and passes through easy country along the Chenab Valley. A canal has lately been dug in the same direction, and the soil being virgin, bumper crops have been raised during the last two years, in fact, the grain has been rotting at site from want of means of transport. I doubt if the Government of India would permit a company to construct this railway, as

it would interfere considerably with the earnings of the North-Western Railway. The Director-General has received the report and estimates, but he does not tell us the cost per mile; I can, therefore, only make a guess that it would not exceed £3,600 per mile on the standard gauge, taking twenty rupees to the sovereign.

2. *The Delhi-Minchinabad-Bahwalpur and Rohri-Kotri Railways* (*Standard Gauge*).—These two lines should be grouped together, as they virtually belong to the same system, the object being to make shorter tracks from the grain districts round about Delhi to Karachi, again cutting off the Lahore corner, but on the south side, not on the north, as in the case of the Wazirabad-Multan Railway.

The first portion is to go from Delhi *viâ* Rohtak, Jhind, Tohannah, Bhatinda, Minchinabad (called after Colonel Minchin, the well-known Commissioner of those parts) to Samasata on the North-Western Railway, about 400 miles in all. I know some 150 miles of this country well, as I was in the Hansi-Hissar districts for two years. The greater part of this route passes through grand grain districts, and when there is a good rainfall splendid crops are raised; in addition the country is irrigated by the Western Jumna and Sirhind Canals. The grades will be light and the curves easy, and there is only one large river—the Ghazzar—to cross. The project has only just been completed, so I am compelled to guess again that the cost will not exceed £3,800 per mile.

In *Indian Engineering* of October last, it is stated that "four financial houses in the City have submitted proposals for the making of the Delhi-Bhatinda-Bawalpur Railway, and these the Secretary of State has taken to Wolverhampton with him to study in seclusion." We shall await with interest the outcome of this study.

The Rohri-Kotri Line is a chord cutting off the Sehwan and Larkana portion. In the old days, when the Indus Valley was being constructed, the Indus gave a great deal of trouble, and was constantly breaching the line. So Colonel Bonus, the engineer-in-chief, determined to go through the heavy cuttings at Sehwan and keep the right bank of the river instead of following the valley of the Nara on the left bank of the Indus, as it is now proposed to do. During the last fifteen years this country has never been flooded, so that Colonel Bonus's fears have not been realised. The distance is 206 miles, and the cost, including a large bridge at Kotri, is estimated a £3,870 per mile, taking the rupee at a shilling A large staff, under Mr. Stent as engineer-in-chief, has just been staking out the line, for *Indian Engineering* reports that "a conference of engineers was held at Sakkur, last Thursday, to consider the alignment of the new chord from Rohri to Kotri." Personally, I doubt if the Government of India will allow companies to build either of these two chords, for the traffic of the North-Western Railway would again be interfered with enormously, the tendency of all traffic being to take the shortest route.

3. *The Rai-Bareli-Benares Railway.*—This line will run *viâ* Jais, Amethi, Partabgarh, and Badshadpur, to Benares. I know this country thoroughly well, as I staked out some seventy odd miles on this very route, and marched over the remainder under the late Major Whiteford. Our party went to Jaunpur, but apparently the alignment has been altered to Benares, an improvement I should think. The whole of this country is thickly populated, being 440 to the square mile. Here and there you come across *usar* land that is covered with saltpetre, but every bit of the rest is cultivated with different kinds of cereals and some opium. Near Partabgarh the country is a little rough; all the rest is perfectly flat, seldom exceeding a difference of level of 3 ft. per mile, and there is only one river, the Sai, at Partabgarh, to cross. This line would act as a chord to the Oudh and Rohilkhand Railway, the distance from Rai Bareli to Benares being 139 miles, and the cost is estimated at £3,000 per mile, taking the sovereign at 20 rupees. I doubt if the Government of India would permit a company to construct this route, as the traffic earnings of the Oudh and Rohilkhand Railway would diminish very considerably in consequence of its construction.

4. *The Rutlam-Muttra and Rutlam-Ujain Railways.*—This really belongs to one project. The Rutlam-Muttra is a well-known project to get a shorter cut to Bombay from the grain districts round about Delhi by the broad gauge instead of *viâ* the Rajputana-Malwa route. It is well known that at times the resources of the Rajputana-Malwa Railway are taxed to their utmost to carry all the traffic that is offered, especially after a good harvest, so that either the narrow gauge Rajputana-Malwa must be doubled, or another route provided in the near future. The proposed alignment runs *viâ* Jhalraputam,

Kerowli, Bhurtpur to Multra, 400 miles, and the estimate works out to £3,820 per mile. I presume the alignment will be continued *viâ* Brindaban to Delhi and Aligarh.

The Rutlam-Ujain Railway is only 52 miles in length, and comes to £3,960 per mile, and is intended to connect the important town of Ujain to the above system. Now, here are two lines which the Government of India would, I feel sure, willingly grant to companies to construct. Moreover, they would pay from the day they were opened, and a handsome dividend would be received in a few years. As the Rutlam-Muttra makes a shorter cut from Delhi to Bombay than the Rajputana-Malwa does, it is sure to get a good through traffic, while the local traffic would also be considerable.

It will be noticed that the first-class investments recommended have all been on the standard, or broad gauge of 5 ft. 6 in. At present I do not know any metre gauge line which can be recommended as a really first-class investment, because sufficient information is not forthcoming in the Director-General's Administration Report. There can be no doubt that there are such lines, as a private firm has offered to construct a line from Mangalore to Assikeri, 137 miles, from Hassan to Mysore, 66 miles, and from Nanjanjud to Erode, 114 miles—all these three routes being in the Madras Presidency. Previously only reconnaissances existed, for the detailed surveys were only sanctioned last cold weather, when separated parties of engineers were posted. This private firm must, therefore, have had its own engineers, also information at command which has not been supplied to us.

(B). Sound Second-class Investments.

Standard Gauge.

1. The Ghaziabad-Moradabad-Chandausi Railway.
2. The Ludhiana-Ferozpur Railway.
3. The Aonla-Budaon Railway.
4. The Cuttack - Midnapur - Calcutta and Madras Bezwada Railways.
5. The Singia-Madaripur-Chandpur Railway.

Metre Gauge.

6. The Bezwada-Masulipatam Railway.
7. The Samon-Myingyan Railway in Burma.
8. The Mandalay-Kunlon Railway in Burma.
9. The Chittagong-Akyab-Minhla Railway, to connect India with Burma.

1. *The Ghaziabad-Moradabad-Chandausi Railway.*—It is proposed to run a main line from Ghaziabad, on the East Indian Railway, *viâ* Gurmuktassar, to Moradabad, 85½ miles, and a branch line, 45 miles, from Gurmuktassar to Chandausi on the Oudh and Rohilkhand Railway, the total being 131 miles.

Gurmuktassar is a famous place for pilgrimages. There is also a large trade between Moradabad and Delhi, or Meerut. At present this has to go *viâ* Saharanpur, making the distance between Delhi and Moradabad 165 miles, or two sides of an isosceles triangle, the real distance between Delhi and Moradabad being only 98 miles. The main line would serve Amroha and Hapur, which have 36,000 and 15,000 inhabitants respectively; while the branch would pass through Sambhal, which is said to contain 37,000 people. I know this part of the country fairly well, as I was resident engineer at Moradabad for some months. The country, on the whole, is easy for a railway, the Ganges bridge at Gurmuktassar being a big item. Without the bridge, the line could probably be made for under £3,000 per mile, taking the rupee at a shilling; the complete estimates are not given by the Director-General, so I do not venture to make a guess.

While the bridge was building, a ferry could be used, and thus the opening of the line need not be delayed, for the line could be constructed much quicker than the bridge—say, two years for the line and four or five for the bridge—as no doubt special plant would be required for such a large undertaking.

2. *The Ludhiana - Ferozpur Railway.*—Before the Rewari-Ferozpur line was constructed, there used to be very heavy traffic along the road from Ludhiana to Ferozpur, and *vice versâ*; on this account, lots of dacoits or highwaymen were constantly prowling about for victims, and even now the traffic is considerable. Mr. Warburton, the well-known district superintendent of Punjab police, soon quenched the ardour of these gentry by going himself in an ekka disguised as a *purda-nashin* woman bedecked in jewellery and getting molested. The yokels walking along the road curiously turned out to be policemen in disguise. I remember during Christmas, 1878, handsome rewards were distributed to the policemen by the orders of the Punjab Government for capturing these dacoits.

The length of this route would be 76 miles, and I presume could be done under £3,500 per mile. The Director-General states that the estimates were not ready at the time of publi-

cation of his last report. Ludhiana is a well-known centre for grain and spinning of all kinds carried on by the Cashmiris. I feel confident this branch would pay satisfactorily when once opened. I have been three times to Ludhiana shooting all about the districts and also studying the vernaculars, so I know the country fairly well. I am told that many petitions have been sent to Government by the local traders, begging and praying that this branch might be constructed, and that some of these men have even offered to plank down part of the money, but the amount offered is not sufficient to construct the whole branch.

Ferozpur was of course *the* arsenal of the north until Rawal Pindi made it play second fiddle.

3. *The Aonla-Budaon Railway.*—Budaon is a town of 36,000 inhabitants, and Aonla is a small station on the Oudh and Rohilkhand Railway, the distance being 19 miles. Only one river, the Kurrah, has to be crossed, the estimate works out to £3,070 per mile. The Oudh and Rohilkhand Railway have a large stock of second-hand 60 lb. steel rails with wrought-iron sleepers, which have been taken up from the main line and which could be utilised. This is only a small project it is true, still it would pay, as the country is densely populated, being some 400 odd to the square mile. When I was district engineer at Moradabad, Aonla was under my charge, though I never went to Budaon. I believe Budaon is one of the places where opium is manufactured, if so, land would be very valuable.

4. *The Cuttack-Midnapur-Calcutta and Madras-Bezwada Railways.*—These two projects really belong to one system to connect Calcutta direct with Madras, and is called the "East Coast Railway." The greater portion of the East-Coast Railway is either constructed or will be completed shortly.

For the Cuttack-Midnapur-Calcutta section two projects have been considered. Both these projects start from Naraj on the Mahanadi, opposite Cuttack, and run *viâ* Balasore and Midnapur to Panchkura, 218¾ miles, the estimate of this being £5,662 per mile, taking 20 rupees to the sovereign. It is a densely populated district under heavy rice cultivation; there are four large rivers to cross, the rest of the bridging being light. On account of these four large bridges the estimate is somewhat high; from Panchkura there are two projects.

In the first project, the alignment crosses the Rupnarain and Damuda rivers and tunnels under the Hoogley at Budge-Budge. Fro Naraj to Nangi, on the Eastern Bengal Rai way, is 254 miles, costing £8,134 per mile.

In the second project, a line is run straig from Panchkura to Diamond Harbour. A Diamond Harbour the Hoogley is 1½ mil across at ordinary times, and two or thre times this width in floods, so a waggon tra shipping ferry is proposed, and shelter dock will be required on both banks of the river also hydraulic lifting apparatus for transhipping the waggons from the rails to the barge and *vice-versâ*. The distance from Cuttack t Diamond Harbour is 257¾ miles, at a mileag rate of £6,820.

The location of the Madras-Bezwada Railway was commenced in December, 1893, unde Mr. Shadbolt as engineer-in-chief, so th estimates were not ready when the Directo General published his last report; the distanc was found to be 291 miles. I see in *Indian Engineering* that Government have ordere the construction of some ten miles just out o Madras, so a commencement must have bee made by this time. This link must, of course be constructed as was foreseen by Sir Guilford Molesworth and other engineers. I believe the Madras railway authorities long ago offered to construct this length, having previously made a survey. On the other hand the Government of India hoped that the Bellary-Kistna and the Nizam's Railways would find an outlet at Masulipatam, and tha Vizagapatam might also be developed into a port, without sending all the cargo to be shipped at Madras.

(5) *The Singia-Madaripur-Chandpur Railway.*—The object of this project is to connect the Bengal Central Railway with the Assam-Bengal Railway, and thus forge a link in the great chain which must eventually connect India with Burma. Between Singia and Madaripur the distance is 64 miles, and no difficulty has been experienced. Between Madaripur and Chandpur is only 15 miles, but on account of the changing courses of the Ganges, Megna, and Arial Khân, extensive surveys will be required to fix the proper alignment. The first portion will probably not exceed £5,000 per mile; the latter 15 miles will, no doubt, require protective banks of stone, and the estimates may run up to £10,000 per mile, or even more, or as we say in India, "two lakhs a mile."

We will now consider sound second-class investments on the metre gauge.

6. *The Bezwada-Mazulipatam Railway.*—

he Southern Mahratta Company have proosed to construct this 50 miles, costing ;2,775 per mile, on account of this being the atural termination at the port of Masulipatam f the old Bellary-Kistna Railway. It is not et known whether the Secretary of State has greed to the company's proposals.

We will now leave India, and consider some f the railways in the adjoining province of Burma, which is also under the Government f India.

7. *The Samon-Myingyan Railway.*—Myingyan is a fairly large town about 50 miles outh of Mandalay, where all the Chindwin rade arrives and is carried down to Rangoon by the Irrawadi Flotilla Company. It is desired to connect Myingyan with the Burma State Railway. Three rival schemes were proposed, namely, the Meiktila-Myingyan, the Samon-Myingyan, and the Thadow-Myingyan, each scheme having its own supporters.

The military authorities wanted the Meiktila-Myingyan route, as the road used to be infested with dacoits, so I was sent on a survey, and found the country difficult, that is to say hat grades of 1 in 100 could only be obtained by heavy banks and cuttings. In my time (1892) the Thadow-Myingyan scheme had never been mentioned, so somebody must have started this idea later. At any rate Mr. Lilley, who is one of our engineers, and has an excellent eye for country, and who examined several routes in these parts, once told me that there was no doubt that the Samon-Myingyan was *the* route to adopt. The Director-General says that relative estimates for the three routes were being compiled at the time of his last report, so I presume we shall get this information in his next report. If I may venture to make a guess on the safe side, the cost will not exceed half a lakh, or £2,500 per mile.

8. *The Mandalay-Kunlon Railway.*—I was on the survey of the first portion from Mandalay to Thibaw, 135 miles, under Mr. Bagley as engineer-in-chief. I worked 10 miles W., and 40 miles E. of Maymyo, which is a small military cantonment 44½ miles N.E. of Mandalay. Burma requires a sanatorium, and Maymyo is the only place which has yet been found where there is abundant space for building, and a good supply of excellent water. It is some 3,600 feet above the sea. Twenty miles of rack railway, on a grade of 8 per cent. will be required, for you have to rise 3,300 feet. Better country than round about Maymyo I have never been in, either in India or in Burma; it is absolutely "a land flowing with milk and honey," that is to say, well-watered and salubrious. There is also no doubt that the ground was once largely cultivated, but the Burmese so maltreated the Shans, that the latter ran away to seek British protection. A good cart road has now been made to Lashio, some 185 miles N.E. of Mandalay, and though our line did not follow the road, still it was extremely useful for bringing up our supplies; we had a police escort of fifteen sepoys, but the majority of travellers go about the country without any escort whatever.

I see from *Indian Engineering* that very difficult country has been encountered beyond Thibaw. Still Government ought to construct the first section to Maymyo, if not to Thibaw, for this would open up the country enormously; moreover, the railway will get timber, lac, cattle, pickled tea, wool and hides, and the through traffic from the gold-fields of Yunnan. Besides, the Shans are sure to travel as freely as the Burmans do, as they have no caste prejudices.

I notice that in the discussion on the Burma-China Railway, in this Society's *Journal* for March, 1890, Mr. Holt Hallett preferred his Burma-Siam and China Railway to this Mandalay-Kunlon route, proposed by Mr. Sheriff on the grounds that it would be easier to construct, and relatively cheaper. Sir Charles Bernard, who was once Chief Commissioner of Burma, replied most appropriately that "if British capital had to be used, and especially if any way, directly or indirectly, the Indian treasury was to be answerable for the finance of the railway, there were very strong reasons for carrying the line as far as possible through British-Indian territory."

I am unable to lay my hands on Mr. Bagley's report and estimates, so I am not not quite certain what he made out the cost to be. If, however, my memory has not played me false, I think it was, up to Thibaw, Rs. 90,000 per mile, or say £4,500 per mile.

Up to the present I have chiefly mentioned railways with which I have been more or less associated, and have, therefore, trodden on safe ground. I am now about to mention one of which I know little, yet think it should be classed under the head of second-class investments, for it is a line which is bound to be made sooner or later.

9. *The Chittagong-Akyab-Minhla Railway.*—The survey was commenced in November, 1893, under Mr. Way as engineer-

in-chief—previously there had been a reconnaissance under Mr. Woods, both Coopershill engineers. The survey was begun from the Minhla, or Burma end, and will take two seasons to finish. The first thirty-six miles were moderately heavy, then for twenty-two miles we get grades of 1 in 100, and 8^c curves in two places. After this, twenty-one miles require 1 in 40 grades, with a tunnel 3,900 feet long, and descending grades of 1 in 40 to Arracan. The whole project will probably be 420 miles, costing £5,000 per mile. The Director-General's next report will, no doubt, give us more detailed information with accurate estimates.

A good deal of the country traversed is undeveloped though fertile, so that no company is likely to take up the construction unless a guaranteed rate of interest is given by the Secretary of State for India. Assuming, however, that the line is made, it ought to do a good business, for it would take away all the traffic which now goes by steamers from Calcutta to Rangoon, and this is a large amount. Again, Burma is thinly populated, while in certain parts of India the population is superabundant; the Hindu moreover objects to the "kala-pani," or proceeding by steamer. If a railway were made, shoals of natives of India would emigrate to a province where wages are high, and land in many parts of Upper Burma easily available and cheap.

(C.) Other Railways.

Whether Sir W. Patrick Andrew's "Euphrates Valley" scheme, or Sir Frederick Goldsmid's "Cyprus-Karachi" Railway, or Messrs. Colquhoun and Hallett's "Burma, Siam, and China Railway" will ever be seriously considered by promoters and the public in general, it is impossible for me to say. For these routes have only been reconnoitred in parts and no detailed surveys made or estimates submitted. On the other hand, the Director-General of Railways gives us a schedule of railways lately surveyed, at present under survey, or recently put forward for consideration. This schedule embraces 45 different schemes, aggregating 6,168 miles; deducting the 2,705 miles which I have already considered under first-class investments or sound second-class investments, we are still left with 3,463 miles, which the Government of India have thought advisable to get surveyed and permanently marked out, ready at any moment to be undertaken when the funds are available. In addition, there are many other projects pigeon-holed in the Simla Public Works Secretari which the Director-General does not eve mention in his report, and which are forgotte by all but those few who have devoted the lives to these matters. I will touch on thre of these also.

Of the railways mentioned in the Directo General's schedule I would suggest fo worthy of consideration, besides those alread investigated, namely:—

1. The Moghal-Sarai-Palamow (Dalton ganj).
2. The Garhara-Monghyr.
3. The Bhatni-Benares with branches.
4. The Sambalpur-Khurda.

1. *The Moghal-Sarai-Palamow (Dalton ganj) Railway.*—This line passes througl rough country, is 150 miles long, at an averag rate of £6,000 per mile. Palamow is at th foot of the Hazaribagh plateau, and all roun this neighbourhood are the principal coal fields of India, following the Damuda rive and its tributaries. In 1893, Bengal produce 1,870,720 tons of coal, or three-quarters of th total produce of India. We all know wha coal-fields have done for England and Belgiun and America, and we naturally expect th same benefits for India, and though the esti mate is high, nothing pays like carrying minerals, especially "black diamonds."

2. *The Garhara-Monghyr Railway* is short line on the left bank of the Ganges costing £2,000 per mile. If constructed i would give an outlet to the produce of th Bengal and North-Western and Tirhut rail ways.

3. *The Bhatni-Benares Railway, with Branches.*—A main line is proposed 90 miles long, costing £3,000 per mile, with 133 miles of branches to Barhaj, Azamgarh, Ghazipur, Jaunpur, and Ballia. This would make a complete network between the Gogra and Ganges rivers, where we have highly-cultivated land with a dense population unprovided with sufficient means of transport for the surplus produce.

4. *The Sambalpur-Khurda Railway.*—This is to connect Sambalpur in the Central Provinces with Khurda on the East Coast Railway, 190½ miles, costing £6,250 per mile. There is an existing road with considerable pilgrim traffic and no railways at all to serve this region. The Administration Report says that the construction "has been postponed for want of funds," so we may hope to see a

ommencement made before many more years ave elapsed.

Sir Theodore Hope, who was at one time ne of our Ministers of Public Works, in this ociety's *Journal* for June, 1890, is a great dvocate for this railway, for he says "Orissa s now virtually unprotected. Let the Governnent look to it; let them, I say, look to it ere roubles come, for a 1,000,000 of human beings erished in Orissa in 1869, and £1,500,000 terling was spent in most futile measures of elief."

I will now take up the three railways which re not mentioned in the Director-General's eport, and which I said are almost forgotten. These are:—

1. The Delhi-Kotri Railway.
2. The Western Bengal Railway.
3. The Benares-Cuttack Railway.

1. *The Delhi-Kotri Railway.*—In 1890 a survey was made, under Mr. Crondace, to connect Delhi directly with Kotri, *viâ* Jaisulmir. I read the report and made some notes; but, unfortunately, am unable to lay my hands on them at the present time. I was also on the survey from Hydrabad (Sindh) to Umarkot, and we joined our survey on to Mr. Crondace's near Sufi Fakir. I am, therefore, well aware of the enormous difficulties to be encountered —the blinding sand-ridges, sometimes 200 and more feet in height, the utter want of water for many miles, and the long distances between the villages. Yet, if one looks at the map, one cannot but be struck by the fact that this is the shortest track from the grain districts round about Delhi to the port of Karachi, and that the Delhi-Bhatinda-Bawalpur and Rohri-Kotri chords cannot be compared to this, the "grand chord."

Colonel Le Mesurier has told us how the Russians have successfully overcome similar difficulties of want of water and sand-ridges in their Central Asian railways; therefore, I say that this line is bound to be made, perhaps not in our lifetime, yet certainly at some future period.

2. *The Western Bengal Railway.*—In 1889 I was on this survey under Mr. Ramsay, as chief engineer. Six divisions surveyed nearly 600 miles from Deoghur (Baidyanath), on the chord line of the East Indian Railway, *viâ* Nya Dumka, Soori, and Cutwa, to Ranaghat, on the Eastern Bengal Railway. If one looks at the map, one cannot help noticing that this route is shorter than the present one from Howrah to the North-West Provinces and Panjâb: the whole of the country is also highly cultivated, densely populated, and untraversed by any railway. The East Indian Railway Company is the great opposer to this scheme, as it would interfere with its monopoly.

3. *The Benares-Cuttack Railway.*—Some eight years ago, a survey was made under Mr. Parker, to connect the two great pilgrim shrines of India, namely, Benares and Puri, which is near Cuttack. This was a nine-days' wonder at the time, and much talked about among the natives; the delay of constructing, however, has caused all interest to die out in the matter. If the Moghal Sarai-Palamow and Sambalpur-Khurda Railways were constructed, they would serve the purpose, and catch the greater portion of the pilgrim traffic, which is continuous, and, at certain festivals, enormously heavy. At present, most of the pilgrims walk or drive from Benares to Asansol, along the grand trunk road, and then *viâ* Midnapur and Balasore to Cuttack, thus wasting an unnecessary amount of time and money. Many even go from Benares to Calcutta by train, and take steamer from Calcutta to Cuttack; but I expect they have to do penance, and give an extra feed to the Brahmins for crossing the "kalapani" or ocean.

As this paper is conceived in a commercial spirit, I have not thought it necessary to refer particularly to military or famine lines, as these are not likely to be at once remunerative, and if required should be constructed by Government.

Just as this paper was about to be sent from Las Palmas to Oxford to be typewritten, I received a newspaper cutting, in which Sir James Kitson asks the Secretary of State for India to kindly give his railway programme for the years 1895-96. Mr. Fowler replies that the Indian Council have sanctioned construction on the following lines:—

(*a*) The Bezwada-Madras, the Rohri-Kotri, the Wazirabad-Lyallpur, the linking up of the metre gauge between Cawnpur and Ramnagar junction and the Rutlam-Ujain.

(*b*) That the Indian Council have also sanctioned extensions on the Bengal North-Western Railway Company's system, namely, the bridge over the Gogra at Bahram Ghat, from Nandpara to Nipalganj, from Gonda to Bulrampur and Tulsipur, and from Bhatni to Turtipur and Bharaj, in all 115 miles.

(*c*) That negotiations are pending with companies to construct railways from Delhi to Samasata, Lakhiserai to Gya, and between Mangalore and Arsikeri.

This is a very good programme, provided it is carried out, as it is proposed to spend 16 crores of rupees up to the 31st March, 1897.

The General Prosperity of India.

The traveller who makes a cold weather trip to India and then comes back, sometimes writes a book on India, or lectures on India's growing poverty, the wretched hotels, the emaciated state of the inhabitants from the effects of opium, the woeful ignorance of the people, their gross idolatries and superstitions, and the dreadful discomforts of travelling in certain parts of the country. The British public will generally listen to this traveller, provided his "views" on missionaries, opium and other matters are in accordance with theirs. Has this traveller studied any of the vernaculars or even Indian history, or reflected on what the British Raj has done for India?

Less than one hundred years ago, in the time of the administration of Marquis Wellesley, when the British Indian Empire was very much smaller than it is now, the wealth of India was concentrated in a few large towns such as Agra, Delhi, Lucknow, Benares, Patna, Murshidabad, Hydrabad (Deccan), and a few towns in the Bombay and Madras Presidencies. There were two or three main trunk roads and a few others. Bombay virtually did not exist, for it was the island of Salsette, and Calcutta was called Fort William, or round about what is now Dalhousie-square. In the villages cowries were the usual means of barter, there being so many hundred to the rupee. What do we find now?

Bombay is the second and Calcutta the seventh largest town in her Majesty's dominions. Towns which were almost unheard of at that time, such as Karachi, Lahore, Amritsar, Ludhiana, Cawnpur, Allahabad, Jhansi, and many towns in the Madras and Bombay Presidencies now do a "roaring trade." Cowries are a curiosity, for silver and copper are freely obtainable in all villages, while excellent roads cross the whole country in every possible direction. Assam and Burma, which were less known at that time than the interior of China is at the present moment, are now flourishing provinces which contribute considerably to the common exchequer. What has brought this about? The answer is, good administration, with public works, especially railways and canals.

Sir William Hunter, who was the compiler of the "Gazetteer of India," and Collector of Statistics for the Government of India for several years, in this Society's *Journal* f[or] February, 1893, says, "the result of the for[e]going causes—administration and public worl[ks] —has been an expansion of Indian commer[ce] such as the world has scarcely ever seen, ar[nd] which would have been regarded as an in[m]possible dream in any Asiatic country 35 yea[rs] ago. In 1858 the Court of Directors reporte[d] with pride, the total Indian exports and in[m]ports of merchandise by sea at $39\frac{3}{4}$ millions [of] rupees. In 1891 the total, including treasur[e] was $196\frac{1}{4}$ millions of rupees. In 1858 Ind[ia] was chiefly known as a dealer in drugs, dye[s] and luxuries. She is now one of the large[st] merchants in the world in food-grains, fibre[s] and other staples of universal consumption."

The *beau ideal* of happy and content[ed] India, according to Musulman writers, wa[s] when a man could go about the bazaars [of] some mythical city—possibly Delhi, Peshawu[r] or Kabul—throwing up coins in his hands ar[nd] was not robbed openly, the treasury was fu[ll] and the army contented. We who ha[ve] laboured among the people and made i[n]quiries from them know that a good deal [of] this panegyric was "high falutin" intende[d] to tickle the ears of the emperor. The arm[y] was really a rabble, the pay always in arrear[s]. If the treasury happened to get full by squee[z]ing the rich or imposing an extra tax, th[e] emperor and his courtiers first helped them[]selves freely, a small instalment was doled o[ut] to the heads of departments, but uncommon[ly] little cash filtered down to the subordinate[s] and of course there were no fixed salaries. A[t] any rate any person can now go through th[e] bazaars of any town or village in India [or] Burma and throw up gold mohurs—if he ha[s] them—and catch them, and no man dare mal[ke] him afraid in public, if he has good nerve[s] but the smartest district superintendent [of] police cannot prevent him from being tracke[d] home and robbed at night, if he will be s[o] foolhardy. The treasury is considerab[ly] fuller than ever it was before, and even[-]handed justice administered to all alike, ric[h] or poor, although the natives of India hav[e] not fought for their charters as the Englis[h] have had to fight for theirs. I ask, durin[g] the Mussulman emperors, were there ever on[e-]tenth or even one-twentieth of the court[s,] schools, police thannahs, canals, roads, [or] forests, that there are now? Not to mentio[n] post-offices, hospitals, telegraphs or railway[s] which were begun under the British Raj.

Young India who has gone to school ar[nd] college invariably wears English-cut coa[ts]

d shirts, sometimes even trousers, neckties, llars, and a sola topi. He uses knives and ks, tables and chairs, he smokes cigars, nks whiskey, plays cricket or tennis, and lulges in patent-leather boots, mixed biscuits d tea. In fact he is getting "English, ite English you know."

Go into the villages and you will see men, men, and children, busy in the fields, for bunia or money-lender has given an vance, and a certain amount of grain must forthcoming at harvest-time; cattle are l, for famines are not allowed to depopulate villages as they did before, and there is an of general prosperity about the country le. Take a walk round the village and you ll come across a school, police thannah, and ean tanks for drinking-water. Go in and amine the school and give a few small izes, and you will be astonished at the proiency of the scholars in the vernaculars, thmetic and English, not to mention ography, history, or mathematics.

I say then if such a transformation has taken ice in less than three generations, what may t occur in another three generations if only lways are prosecuted with vigour?

Of course, there is a certain amount of m poverty and wretchedness in the overowded portions of the North-West Provinces d Madras, for the people will not emigrate ely, and get entangled in the meshes of the ney-lender, but these misfortunes exist in parts of the world, and are not limited to lia alone.

In a very interesting paper on "Indian ilways," Sir Juland Danvers, in this ciety's *Journal* for February, 1877, notices various effects of railways on the social, litical, and commercial aspects of the intry, to all of which statements I heartily ree. He says, "nothing shows the effect our rule upon India more than railways. It visible, tangible, felt by all." He mains that the effects are even greater than se of liberty, security, justice, or irrigation. New markets have been opened to places viously shut out, commodities have been plied from sources before unknown to lers in them. Energy has been aroused, d the desire to exchange and barter goods s been increased." Regarded in a political int of view, Sir Juland Danvers says, Whatever enables the military force to be ved with ease and expedition must be a irce of strength to the Government, and a ans of preserving peace and security to the country. Railways do this at a large saving of money besides, and bring home, moreover, to the native observer, whether within or without our territory, the wonderful energy, power, and resources of the governing race." Sir Juland Danvers's remarks also on the social aspects of railways are most pertinent, and I make no excuse for quoting them. "The first effect was to improve the wages of the labourer, and to open his eyes to the fact that he possessed a property, the value of which was regulated by natural laws, and not, as was often the case before, by the will and caprice of his employer. The railways will also improve the condition of the people by enabling them to be supplied with cheaper food and raiment, and helping to educate them. As they go to and fro they will see and learn much that they never thought before. There will also be more intercourse and more friction." And then Sir Juland Danvers shows how the power of "caste" has been shaken, and comforts multiplied many fold.

Having been on the construction of five Indian railways, I can verify the statement of the rise of wages in every case, but I will just give one instance. When we went to Nandial, on the Bellary-Kistna Railway, in 1883, we could get coolies at $1\frac{1}{2}$ to 2 annas a day; within a few weeks they were demanding 3 annas, and before a year had passed they wanted 4 annas. Up in the hilly portions, only 13 miles from Nandial, we paid 6 or 8 annas, and sometimes we could not get labour, though we offered 10 or 12 annas, as the climate was unhealthy.

Unfortunately India has not the coal and iron which was the making of England. Still, large quantities of coal, iron, and limestone do exist, though scattered about. In 1893 India produced over $2\frac{1}{2}$ millions of tons of coal which were used in the country. The best known iron-works are those of the Bengal Iron and Steel Company at Barrakur, where over 25,000 tons of pig iron are turned out per annum. India possesses many products of the soil which do not exist at all in England, such as diamonds, gold, pearls, cotton, timber, jute, silk, tea, coffee, opium, saltpetre, petroleum, and fibres. In industrial arts India is a long way ahead of England, such as the *repoussé* copper work of Moradabad, the mosaics, ivories or wood carving of Agra, Delhi, or Lucknow, the silver filigree work of Cashmir, Kach, or Madras, or the magnificent *champlevé* enamels of Jaipur. All these and many more sources of wealth are being improved and developed yearly. Sir Juland Danvers in

another paper says, "In addition to the factories already mentioned — cotton, wool, iron—there are a number of others connected with miscellaneous industries. There are 38 flour-mills, 33 oil-mills, 68 indigo factories, and 26 ice factories. There are 27 establishments were aërated waters are made, 48 iron and brass foundries, 19 jute presses, also rope works, saw-mills, potteries, and soap manufactories."

I have briefly sketched India's general prosperity and security to show that India is in a fitter state for English enterprise than Turkey, Spain, or the South American Republics, countries where English capital flows freely because interest is guaranteed for the investments made.

The Parliamentary Commission which was appointed in 1884 to inquire into India's railway needs stated that India required at least 60,000 miles of lines to develop its resources; we have at present 18,458 miles, or less than one-third of this quantity. In fact there is less mileage of railways in India than in the British Isles, yet India and Burma contain 16 times as many square miles, having over 2 millions against 119,000 square miles in the British Isles, and a total population of 267·6 millions against 37·8 millions, or 8 times as great. Again, India alone is said to be increasing at the rate of 3·3 millions per annum. If new districts are not opened out and jungles cleared, how will this increase of population find the means of subsistence?

Main Results of Working Railways for Years Ending 31st Dec., 1892, and 31st Dec., 1893.

	Total of all Gauges.		Increase in 1893.	Per-centage of increase.
	1892.	1893.		
Open mileage (miles)	17,768	18,458	690	3·88
Number of passengers booked (millions)	127·3	135·5	8·2	6·38
Tonnage of goods booked (millions)	26·3	28·8	2·5	9·5
Passengers, 1st class (average distance)	77·3	77·1	−0·14	−0·18
Do. 2nd class do.	50·1	48·2	−1·82	−3·63
Do. 3rd & 4th class do.	41·7	41·04	0·66	1·58
Train miles (millions)	60·6	62·7	2·1	3·5
Gross Earnings.				
Coaching total (crores of rupees)	7·74	8·19	41 lakhs	5·81
Goods total do.	14.77	15·21	44 lakhs	2·98
Gross earnings per mean mile worked per week	252·71	254·38	1·67	0·66
Per-centage of working expenses on gross earnings	46·94	47·12	0·18	—
Net earnings (crores of rupees)	12·32	12·73	41 lakhs	3·33
Per-centage of net earnings on total capital outlay on line, including suspense account	5·42	5·46	0·04	—

The Particular Prosperity of Indian Railways at the Present Moment.

I append a comparative Table from the Director-General's Administration Report, giving the main results of the working of all railways for the years ending 31st December, 1892, and 31st December, 1893, from which it will be seen that there has been a steady increase all along the line. The total gross earnings for coaching traffic has increased by 5·81 per cent., and the goods traffic by 2·98 per cent. There has been a slight decrease in steamboat, telegraph, and miscellaneous earnings, still leaving a net increase of 3·68 per cent. The gross earnings per mean mile worked per week has increased 0·66 per cent.; the working expenses have increased, chiefly due to extra carriages and waggons ordered, yet the per-centage of working expenses on gross earnings has only increased 0·18. The grand result stands out that the per-centage of net earnings on total capital outlay on open line, including suspense account, shows an increase of 0·04 over 1892, being at the very handsome rate of 5·46 per cent.

Engineering of 5th October last has a leading article on "Indian Railway Development," which should be circulated broadcast.

"With the existing railways of India earning a profit of 5·46 per cent. on the capital expenditure, at a time when the railway systems of nearly all countries experience decreased results, some encouragement should be afforded for prosecuting railway extensions, especially when the return in Britain is but 3·60 per cent., in United States 3 per cent., and in the Australian Colonies from 2 to 3¼ per cent." The article then ends by saying, "It is very evident, putting aside the difficulties of guaranteed rates and exchange, that the Indian railway system, as a whole, gives good results. It is true that, just as the East Indian and some of the other large lines are economically managed, others are not satisfactorily worked; but, as a whole, the results are encouraging, and in view of the facts that the improved credit of Government admits of money being got at a very much less interest, and that traffic awaits the construction of the lines we have described, as well as others not referred to in detail, we hope that in the future the plea of financial considerations will not be resorted to so often, and never till some genuine effort of financing has been put forth. The exploiting of works for the development of the resources of India is probably regarded by the native population as an earnest of our desire for their prosperity, and resourceful energy in this direction must ever tighten the bond between this country and her greatest dependency." I shall presently put forth a financial scheme; meanwhile it is necessary to add a few words.

The Chambers of Commerce of Madras, Calcutta, and Bombay, as also those in England, are constantly urging on the Government of India to prosecute railways, all the viceroys from the time of Lord Lawrence have been in favour of extending railways, and, lastly, that severe critic of Indian finance, Mr. Dadabhai Naoroji, M.P., looks to railways and canals as the forlorn hope of India's salvation, "for on these alone do the material salvation of India and the strength and benefit of English rule depend." It is, therefore, high time that the Secretary of State was up and doing. I shall, indeed, be surprised if the mileage opened for 1894 exceeds that for 1893, namely, 690 miles.

Mr. J. M. Maclean, M.P., who was editor of the *Bombay Gazette* for many years, in this Society's *Journal* for February, 1884, says:—"The mode of converting the Indian railways into a directly profitable pecuniary speculation for the State, cannot but be unfair and injurious to the commerce and industry of India." Each railway ought to be treated as a separate undertaking. He then goes on to say that it is now admitted by all, that the indirect advantages, such as taxes, which the Indian Government has derived from railways have more than borne out the sanguine anticipations of Lord Dalhousie, and that, therefore, it is most unjust that good investments should have "to pay for the unremunerative character of the traffic on military and administrative lines, *the loss on which ought to fall upon the general taxpayer, in whose interest they were undertaken*." The italics are mine.

Companies so despair of the Secretary of State making a move, that the *Times* city article for 17th November last says, "The East Indian Railway Company are promoting a Bill in Parliament next Session to enable it to enter into agreements as to the construction or extension of railways, and to guarantee interest on them out of the receipts of the East Indian Railway, and to enable it to raise further capital."

The reasons why Indian railways pay so well are, because land is cheap, labour plentiful, rates kept down by the engineers, and money not squandered in jobbery, promoting or fighting rival schemes before Parliament.

After this paper was written, a friend fortunately sent me the magazine *India*, for December last, in which there is an article by Mr. Donald Reid, "A Protest against Railway Extension in India." Mr. Reid is an indigo planter in Behar, and states that Government instead of building railways, should spend the money "to supply the rayats with suitable manure for wheat fields." Mr. Reid then gives some account of the low rate of wages in the North-West Provinces, of the poverty of some of the people, and wishes the Government to go back to the native method of taking the revenue in kind, instead of in cash.

I am not aware of any precedent that any Government at any time has ever supplied manure to its community. If the manure were supplied the people would soon come to ask to be supplied daily with the bread which comes from the manure. There is no doubt the North-West Provinces are overcrowded, and emigration and industries are the only outlook to prevent this dire distress. It is quite impossible for any civilised Government to go back to the old method of taking in kind, for in the old days cash was scarce.

In 1876, I was on the Kosi extension survey of the Tirhut State Railway, and all the indigo planters I came across were only too pleased

with the prospect of a railway coming in their direction. So Mr. Reid's opinion is certainly opposed to their's. Since then many miles of line have been opened up in Behar. Mr. Reid certainly holds selfish views; having got as many railways in Behar as are necessary for the present, he does not care in the least whether other parts of India or Burma are served with communications or not. I would draw Mr. Reid's attention to a paragraph in *Indian Engineering*, of 8th of December last, by "Lepidodendron," in a mining letter:—

"If the daily papers are to be believed, it appears there are hundreds and thousands of natives in all parts of India who never get a 'square meal' a day, as there is no means of their obtaining employment. If this is so, I think it is time for the Indian Government to rouse itself, and send these starving thousands down to the colliery district, and I guarantee they will get plenty to eat and drink. The Indian Mining Association should sound Government in the matter."

A Suggestion for the Director-General of Railways.

Everyone who has been in the service knows that before a railway survey is started a vast amount of information has been collected on the project. Some one starts an idea that a railway is required in a particular locality. The Deputy-Commissioner or Collector is asked to submit a report, stating the traffic in that part, the number of carts, pack animals and people who move about, the pilgrimages, melas, markets, and other gatherings. The Commissioner, in forwarding the report, adds his quota, when the document reaches the Local Government or Administration, the Public Works Secretary has his say, and when the report reaches the Government of it is finally referred to the Director-General of Railways for his opinion. If sufficient reasons have been given a railway survey is ordered.

Now, what we desire is, that the Director-General, in his Administration Report, should state concisely what the probable traffic on each line would be, for this information is in his office, and would swell his report by only a few pages. He need not give all the opinions expressed, simply a summary of them in the briefest possible manner. If the Government of India really wish companies to come forward and take up any of the 45 schemes proposed, this information is absolutely necessary, for the company has to get it somehow, in order to make an approximate estimate of the probable earnings of the line, as no one will invest money unless he is first of all assured that a good return is likely to be obtained for his investment.

The Financial Aspects of the Question.

In the Government of India Circular No. 924R, of 15th September, 1893, the concessions offered to companies for constructing railways are:—

1. Free use of land.

2. The provision of rolling stock and the maintenance and working of the new lines at favourable rates by the main line administration.

3. The free use of surveys, &c., made at State expense.

4. The carriage of stores and materials over State lines at favourable rates.

5. The grant of limited rebate from the main line earnings towards ensuring the proprietors of the new lines a dividend of 4 per cent. per annum on the approved capital expenditure.

6. Authority will be given to charge to capital account such sum as will suffice to pay interest at 4 per cent. during construction on the paid-up capital.

When the Government of India issued this circular it was possibly thought that the concessions were liberal, and that there would be a "boom" in Indian railways; no such boom has occurred, as the concessions are not attractive enough.

Eight years ago, when I was home on furlough, I used to discuss Indian financial matters with my father, who was a "city man," and well known in India in his day as the manager of the Delhi Bank. He was, moreover, a friend of the great Lawrences, and was often consulted by them in financial matters. Unfortunately he is not alive to aid me with his counsel. I hope, therefore, that city critics will deal leniently with one who ventures "not wisely but too well."

I beg leave to suggest two methods by which money might be obtained to extend Indian railways:—(*a.*) A fund to be called the Indian Railway Fund, to be raised by the Secretary of State at the rate of two to four millions sterling, or crores of rupees if he prefers them, per annum, for twenty years at $3\frac{1}{2}$ per cent. per annum. Assuming the average cost to be £4,000 per mile, this would give us 500 miles per annum, or 10,000 miles of railway at least in twenty years. The accounts of this fund to be kept separate, and not mixed up with the general exchequer. (*b.*) Companies might be asked to come forward to construct certain

nes, in which case, in addition to the concessions granted in the above circular, Government must guarantee—

1. Interest at $3\frac{1}{2}$ per cent. during construction of all lines.
2. Three and a half per cent. for 1 to 5 years after construction on my first-class investments, according to circumstances.
3. Three and a half per cent. for 5 or 10 years after construction on my second-class investments, according to circumstances.

Turkey, Spain, the South American Republics, and every other country to which India should be compared, has had to guarantee interest or give up some source of revenue as security in order to obtain railways. How, then, can India expect to have her railways unless she is also prepared to make some sacrifices? Moreover, India is able, financially, to bear the strain better than any of these countries, for the liabilities of the Indian Government, up to 31st March, 1894, are 124 millions tens of rupees in India, and $114\frac{1}{8}$ millions of pounds in England, the assets being 148 millions tens of rupees and 65 million pounds. The liabilities uncovered by assets stand at 49 million pounds diminished by $23\frac{1}{2}$ millions tens of rupees, or say 37 million pounds sterling only. I shall be very glad to be informed of any country in the world whose finances are in such a favourable condition relatively to its income. The Government of India might, therefore, easily borrow 40 million pounds or even 80 million pounds in twenty years for productive public works, and its finances would still be well within the mark of stable equilibrium.

The usual excuse for not prosecuting railways with vigour is, that the finances of India will not admit of a guarantee being given, that India is taxed to the utmost, and cannot be taxed further. I beg leave to have my doubts on this matter.

Supposing India were suddenly plunged in war, would not money have to be forthcoming somehow? Now, in war you play for heavy stakes; if you win, all is right and you recover expenses; if you lose, you are heavily involved in debt for many years. On the other hand, when the money is laid out in productive public works, whether you get the expected interest or not at once, you still have a property of increasing yearly value, and future generations will reap the benefits if the present one does not do so. As posterity, therefore, will chiefly benefit by the railways or canals when constructed, it seems only fair that we should lay a lien or mortgage on them, just as our forefathers make us bear the burdens for the honour and glory they had in making wars.

It really is not my duty to point out to the Finance Minister to the Government of India further sources of revenue; to show, however, that I have thought over the matter, take a keen interest in it, and appreciate his difficulties, I would humbly submit the following points for consideration:—

1. A certain proportion (say 5 per cent.) of the increase of revenue on land, plantations, property, &c., 15 miles each side of the centre line due to increased railway facilities should be paid to the credit of the proposed railway fund, and ought to be a large amount in time.

2. Tax Indian cigars, tobacco, gold and silver jewellery, Cashmir shawls, and other luxuries which those who require them can afford to pay for.

3. Tax carpets, khinkabs, &c., from Persia and Herat, *viâ* Kandahar.

4. Tax Russian goods coming from Central Asia.

5. Put a tax of 1 anna, or even $\frac{1}{2}$ an anna, on all Indian tea exported, as at least 112 million pounds of tea are annually exported; this tax alone would give at least $3\frac{1}{2}$ million rupees.

6. Increase the manufacture of opium, notwithstanding the prudish shrieks of certain people who claim to be heard on behalf of India's moral prosperity. It is worthy of remark that the report of the Opium Commission under Lord Brassey has not yet been made public, though a full year has elapsed, the majority of witnesses being in favour of opium manufacture being continued.

7. Levy an extra tax on Manchester piece goods; everyone, except the Lancashire mill owners, admits this to be an equitable tax.

If these seven sources of revenue, together with others which no doubt could be thought out, are not sufficient to pay the interest on two to four million sterling (or crores of rupees) to be borrowed by the Secretary of State for productive public works, I shall be extremely surprised, and will, as the Americans say, "take a back seat." There is not a shadow of a doubt that if any other power but England possessed India, some at least of these sources of revenue would very soon be tapped.

There is one point on which I should like to raise a discussion, and that is that a company working under guarantee should be granted power to levy any reasonable rates it chooses on passengers or goods. For example, the old rates were 18 pies, 9 pies, and $4\frac{1}{2}$ pies for first-class, second-class, and third-class passengers respectively, these were lately reduced to 12, 6, 3, or $2\frac{1}{2}$ pies respectively. Now I maintain that until a line is in full swing, say ten years after construction, the higher rates should be permitted; even at the higher rates Indian railway travelling is the cheapest in the world. Where else can one travel first-class for $1\frac{1}{4}$d. per mile, and third-class for $1\frac{1}{2}$ farthings per mile? In what other country too can you send the lowest class of goods at one-tenth of a pie per mile per mound, or say, 0·16d. per ton per mile?

The second-class is a boon to some few passengers, yet it entails a loss on all railways of 3·63 per cent.; by abolishing it and reducing the first-class fares, a saving would be effected.

I have only one matter more to bring forward, and that is that India's resources must be crippled until she has a bimetallic standard or a gold currency. One of these two systems must be adopted shortly. It passes my comprehension that countries like America and Spain which have no gold in circulation, only paper, silver, and copper, can maintain the dollar at par or 8 per cent. reduction, while India's rupee, which is made of excellent silver, should be depreciated 48 per cent. There is no doubt that a stock of gold is kept in America and Spain, but it is also perfectly certain that the amount of gold stowed away in India is "beyond the dreams of avarice." When the Maharaja of Scindia died in 1888 I forget how much gold was found in his coffers, the total savings I believe were valued at five crores of rupees.

Attached to my watch chain is a gold mohur; some 5,000 of these were coined by the Government of India in 1862. As it was found that the cost of production exceeded the sum that would be realised when sold, these little gems were not put into circulation but returned to the fiery furnace whence they came; mine escaped that dreadful fate. If these unfortunate victims had now been in circulation, the rupee would be worth two shillings, the Government of India would have at least a surplus of two millions sterling, and it would not be necessary to call in the aid of companies to help to develop the resources of the country.

DISCUSSION.

The CHAIRMAN said Mr. Parry had read an able paper, dealing not only exhaustively with a particular subject, but branching out into many problems which, if they were to discuss them thoroughly, they would not probably be all agreed upon. As regarded the taxation of Manchester piece-goods, that was a matter that produced considerable difference of opinion in the House of Commons; and he did not think that some would altogether relish a renewal of the controversy, which only a short time ago created considerable acrimony of feeling. He could not claim any special knowledge of this subject, but he could not have sat, as he had done, in the chair of the Chamber of Commerce, and had the opportunity of listening to experts like Mr. Walton and others, without gathering a considerable amount of information upon it, and also forming some conclusions. He took it there could be no question as to the need of railway development in India. It seemed to him the most pressing thing, in the interest not only of India itself, but also in that of those countries with which India was connected. Some ten years ago a committee of the House of Commons presented a report in favour of the matter being dealt with, and since then Lord Northbrook and Lord Lytton had expressed very strong opinions in the same direction. Sir Alexander Rendel estimated the traffic requirements of India at from 50,000 to 60,000 miles, yet she had only about 19,000; and probably 15,000 of those were so placed, that four-fifths of the area of the whole country were supplied only by some 4,000 miles. On the other hand, they could take the United States, with ten times as much railway accommodation. He estimated the total railway capital of the world at 5,000 to 6,000 millions, and that it constituted one-tenth of the total capital of the world, and one-fourth of its invested capital. To use another illustration, if the whole of the money of the world were collected it would only purchase one-third of the railways. In India, however, there were only some 200 millions invested for this purpose, a sum most inconsiderable in the case of a country some 31 times as large as our own. He was also inclined to agree with what had been attributed to the Government of India, viz., too much parsimony, both in the appropriation of funds, and in the stimulation of private enterprise by concessions. He had heard it said that the rebates on interchanged traffic had not been such as to give a stimulus to private enterprise which was so essential in dealing with this matter. They ought all to do their best for England and India in developing the resources of that country in connection with railway enterprise, and also in connection with large irrigation works. As the difficulty of doing much was attributed to financial considerations, what Mr. Parry had said was to the point, that the

timate result was overclouded by immediate considerations. Certainly, if one realised that the sult of railway work would be to increase land lues, and so to give a great increase to the revenue om land, works which might have been constructed would have been eminently reproductive. amentations were often heard in this country at the cal debt, which was accumulating, but he thought far from decrying enterprise in these questions, robably it was the only means of liberating themelves from the crisis in which they were at present laced. In counteracting the devastations of famine, hich was again a source of immense saving, and in imulating industry, a very great financial return om reproductive works would be made in the case f India, and the fact must not be overlooked that e present was a very good opportunity for such orks. Prices were low, and, therefore, railways ould be constructed, and materials and rolling stock rnished on very much better terms than might for ome time present themselves again. He had heard hat Mr. Parry had said about the return on investents, and how India was not handicapped by arliamentary contests and outrageous compensaion, with additions of 10 per cent., which used o be 100 per cent., an addition for compulsory urchase in this country which had no statutory oundation whatever, which was simply customary, nd which had gradually been lessened until it had ow come to the point, which, in his opinion, was till most excessive, of 10 per cent. He did not oubt that the great cost of our railroads, amounting o between 800 and 900 millions sterling, had been reatly aggravated, probably by 50 per cent., by he enormous and wholly disproportionate cost hus incurred. When they lamented, as they ad to do daily, the rates for transport in our wn country, when they considered the great embargo which our own railway rates were n competition with other countries, he did ot hesitate to say that it was to that system hey must attribute a very large portion of the evil. He would ask them all, therefore, to do their best by cultivating public opinion to stimulate the railway enterprise in India, both for the sake of the country, and for the sake of the empire, because one of the trade obstacles of the day were those hostile tariffs, which he would not meet by retaliatory measures, but which were undoubtedly the cause of excluding our goods from foreign markets to a large extent, and which had, through retaliation, shown very disastrous consequences in the tariff wars between Russia and Germany, and Switzerland and France. He did not believe the remedy consisted in imitating the fiscal systems of other countries, but those evils, no doubt, did involve our seeking fresh fields and new markets, and the more these were developed in India and elsewhere, the better. In conclusion, he thought the commercial situation in India would be greatly aggravated, if they did not do their duty by assisting in the development of the country, by what had occurred in the East. They had there one nation springing into almost immediate prominence, showing an assimilation in a quarter of a century of what had taken our own and other countries centuries to develop, an intellectual assimilation which had instantly, almost, given weapons to Japan which would be of the most effective character in dealing with our manufacturing competition. One consequence of this war would be, undoubtedly, the fact that China would have to be re-clothed, and continually clothed. Whether there might be differential duties in any form in favour of Japan by treaty or otherwise, nothing could alter the geographical fact that in questions of transport to China, and in some respects to India, Japan would be under a very great advantage. Under these circumstances, Englishmen must put their own house in order, and do their duty to India. Only by complete justice could we hope to retain India even under peaceful circumstances; only by taking care that its resources were developed. If we left Karachi, the nearest point to England, isolated as it was from any great railway system, and the like, we should probably have a retribution which, as Mr. Parry had indicated, would be infinitely more expensive than the enterprise which might now be undertaken, and be made highly reproductive both to India and to ourselves. Mr. Parry had brought home from India lessons which could not fail to be of great practical advantage to ourselves, and on behalf of the Society he begged to propose to him a most hearty vote of thanks.

Mr. Joseph Walton said he was not in any sense a railway expert, although he had the honour of reading a paper before the Society on the subject of railway extension in India, and its relation to trade in India and this country. Having a strong interest in the question, he took an opportunity of going to India, and travelling over a considerable portion of the country with the express purpose of gaining from railway men and officials on the spot information as to much-needed railway extensions. He should like to draw attention to one point which had just been mentioned—the wonderful opportunity, in point of cheapness, which there was at present for making railways. The average cost of existing railways was, he believed, about £13,000 per mile, but Mr. Parry stated that even standard gauge railways could now be put down for something under £4,000 per mile. If the 18,000 miles already in existence, costing £13,000 per mile and including military and famine lines, earned last year an average of $5\frac{1}{2}$ per cent., how much better chance would there be for some of these new extensions built at a cost of only £4,000 per mile to rapidly become paying investments. Sir Charles Bernard and General Strachey told them that the existing railways meant saving the people of India yearly not less than 40,000,000 sterling. Therefore, it was not only a question of benefiting England by the development of India, but the more railways

were developed in India the greater degree of prosperity would be enjoyed by the people of that country. He considered that this wealthy nation ought to realise to a greater degree the responsibility which rested upon it in having taken upon itself to guide the destinies of nearly 300,000,000 of people in India. Even a poor country like Russia did not hesitate in a few years to spend over 40,000,000 sterling in constructing a railway 6,000 miles in length, across her Asiatic dominions to Vladivostock on the Pacific Ocean, yet England hesitated to spend £50,000,000 or £100,000,000 in the development of India, not only to bring increased trade to this country, but also to benefit that great empire. When in India he visited the coal-fields, and in the Gherria district he saw exposed outcrops of 12 or 13 seams of coal of a total thickness of 180 feet within a distance of a mile and a half. He also saw excellent steam coal being worked in quarries 100 feet in thickness. One of the railways most urgently needed was one mentioned in the paper, the Moghal Serai Palamow and Daltonganj line, which would tap the principal coal-fields. He visited in the north the Chenab River irrigation works, which irrigated 4,000 square miles of country which had hitherto produced practically no vegetation, but now they are capable of growing enormous crops. In discussing this question with Lord Roberts, he advocated most strongly that similar works should be constructed on the Indus further to the northward. It was estimated that 10,000 square miles of country, similar in character to that served by the Chenab works, might be irrigated. Those works paid extremely well, and were estimated to yield as an investment something like 20 per cent., and no doubt the same might be true of the Indus. In the great north-west district there was ample room for development. Why did not the Government push ahead and develop Indian railways? It was not because they did not pay, but because of financial timidity, which was a disgrace to this wealthy nation. No doubt these new extensions would become paying investments, and why should there be this hesitation. The Chairman had indicated what was required, when he said they must create a public opinion in favour of the development of India. The markets of Europe were being closed to us more and more by protective tariffs; and if this great manufacturing country was to enjoy any prosperity at all, it could only be by developing other parts of the empire, and the creation of new markets for British goods. It was for practical men to create this public opinion, so that no matter whatever Government might be in power, they should carry forward with more enterprise a policy in this direction. He felt certain that the little Englanders, as they were called, were rapidly diminishing in numbers. Since he came back from India he had had the pleasure of addressing nearly 40 meetings on this question in the principal industrial centres, including some of the most Radical centres of Wales and the north of England, and in no single case had he failed to carry the audience with him, when he pointed out how necessary it was to keep every square mile of British empire, and how, if we allowed India or others to pass under the control of Russia, Germany or France, British goods would be immediately excluded by protective tariffs, and, from a commercial point of view, we needed to hold all that we had without necessarily advocating anything in the shape of undue aggression. He should be glad if other gentlemen would hold meetings of the same kind throughout the country, so as to further develop the force of public opinion, so that they might be able to command in the House of Commons a majority in favour of this enterprising trade policy.

Mr. ERNEST BENEDICT said the map which he had prepared would show very clearly the enormous areas there were in India still requiring railway development. There was one in the centre of about 200,000 square miles, which had not a single line of railway in it. There was another little area of 10,000 square miles of well-known fertile country, intersected with roads and rivers. Mr. Parry, in mentioning one or two of the schemes, said some were not likely to be sanctioned by the Government because they competed with other lines, and that was perfectly true in several cases. The State had now such large interests in the railways that it was difficult to pick out one which would not compete with a line in which the State was interested, and therefore, as the Railway or Public Works Department did not gain by competition, although the Revenue Department might, the Railway Department was not anxious in any way to promote rival lines, and as the opinions of those in high places had necessarily to be formed under views given to them by their subordinates, it was not to be wondered at that the Government advisers did not see their way to making these competing lines. What was wanted was a strong man to overrule all this, and to say that this line shall be made for the good of the country, whatever the result may be to existing lines. As an instance of that, take the Delhi-Umballa-Kalka Railway, which was built entirely by private enterprise. What did the State say about that line? "We hold the two ends of your line, and we shall only give you such traffic as we choose." But that was not the way to encourage private enterprise. On the other hand, it had taken a long time to get the line from Calcutta to Palamow, where the coal-fields were situated. Year after year it was stated that these coal-fields could not be developed for want of a railway; at last the line is to be made. There was no difficulty in getting sanction for another railway further south, which only competed with an excellent road, a good navigable canal, and the sea, so that there were three roads for getting goods conveyed. Some chord lines had been simply sanctioned on military grounds. It was

in the *Times*, some time ago, of Egypt, that the l experiment on which she entered at a time of e financial pressure, when she had an apparently rwhelming debt, of undertaking works of such oic magnitude as those undertaken by the Works oartment, showed conclusively there might often ı wiser and more economical policy than that of e abstention. In Egypt there was a Lord mer, but in India they had not such a man. ing the difficulty of getting Government sanction these chord lines, the only way was to make what iend of his called dog-tails, in other words make der lines tending towards one another, and then netime or other the Government would be bound connect the two dog-tails together, and form a ough line. They would sanction a feeder line, would not sanction a chord line. Rates in India ıld not be reduced now. When goods were car-l at one-tenth pie per ton per mile, and it hardly d at that, they could not be further reduced. erefore, the only way in which the transport of oduce could be cheapened was by making con-ctions between the fields and the stations. This s done by the Indian Midland Railway by means of encies, as far as fifty miles from the line, which lected the produce and took it to the warehouses the railway stations. Therefore, light lines were nted in the first place, and from that they would t to the full gauge railway. In this manner dia could be developed, and of course if the famine nd could be seized and be used to pay interest a railway loan all financial difficulties would be ercome, and all fear of famine would cease.

Mr. M. Mowat said the map of India showed a untry half the size of Europe with only as many iles of railway as they had in England. During his perience of nearly thirty years as a merchant in e Bombay trade, he had always held that one of the eat things for the future of India, which might save r from pressing difficulties, such as the currency ouble was now giving, was by increasing the rail-ays, so as to develop the resources of the country. ı 1878 and 1879, when he was chairman of the Bom-ay Chamber of Commerce, he went fully into that ıbject for the Famine Commission. It was then ound, from information obtained from reliable ources, that in many parts of the Central Provinces rain was found rotting from the absence of the ıeans of carriage to a market. Happily since then great deal had been done to increase and improve ıe communications, but there was still room for great deal more to be done. He did not now that Sir A. Rendel was much under the mark ı stating that India could do with something like 0,000 miles of railway, as mentioned by the Chairman. Lately the Government had been lisposed to grant concessions to those who would onstruct railways by means of rupee capital, nd no wiser course could possibly be pursued. He vas glad to say that one of the leading firms in Bombay lately floated two lines on that basis. He believed that an extension of that policy would be greatly to the benefit of the country. A great part of the sterling remittance from India to this country was required to pay railway interest, which was something like five millions. No doubt, in many respects, the fall in silver had been a benefit to the natives. In this country rents had had to be reduced, but with the great fall which had had taken place in silver, the Indian ryot had not paid more rent, and had been able to get a larger return in silver for his produce. Mr. Parry had referred to the very low rates for carriage on Indian railways, and they were indeed low for the Government that had to do with them; but where the Government lost to a very large extent on the old railways (such as the Great Indian Peninsula and the Bombay and Baroda), was this that they were constructed by contract at 1s. 10d. per rupee up to the amount of the guaranteed 5 per cent. That 5 per cent. was paid in rupees to the Bombay or Calcutta Treasury, and the Government of India had to allow 1s. 10d. for them here, but at the same time it could only sell its bills at 1s. $1\frac{1}{4}$d., thereby on this railway revenue it lost nearly 9d. per rupee, and the ryot got the benefit of that. For that reason, and for many others, especially as showing that the natives took an interest in the country, he heartily welcomed this new step of granting concessions for railways to be formed by rupee capital. The Chairman had referred to Manchester goods; while they all regretted that there was any necessity for putting a tax on Manchester goods, they agreed that having them put on for revenue purposes it was quite justifiable. But whilst stating that, he would also point out, as one having an interest in a large mill, what the result had been on mill owning trade and capital. In India there were now something like 3,500,000 spindles at work, consuming over a million and a quarter bales of cotton. Of the Indian manufactures, about one-fourth would now come under the excise of yarns of over twenties, and he was informed that the imposition of the Excise, and the trouble in connection with it, was having a harmful effect on the industry. He hoped this would be borne in mind when the subject was again discussed in Parliament; though they all liked to see their own industries thrive, they must remember that India was in a sense a part of Britain, and that everything that hampered her industries unnecessarily ought to be removed.

Mr. T. H. Thornton, C.S.I., wished to ask Mr. Parry if he could give any information with regard to certain proposed extensions of railway enterprise into Beloochistan. Proposals and surveys had been made for railway purposes along the coast of the Persian Gulf to Guada, and then northward through Makran; another railway survey had been made in the Zhob Valley; and another line had been sug-

guested by Sir R. Sandeman to Punjgúr, *viâ* Lus Beyla, and ultimately to Seistan, the granary of Persia. All these proposals had been made, but he had heard nothing of the result, and he would be glad if Mr. Parry could give some information upon the subject. On the general question he would only make one observation. He was very much afraid that they would not get gold capital to flow into India for the benefit of railways until they had tackled the question of the standards, and, therefore, the best plan for developing railways in India was to press for a bimetallic convention.

Brigade-Surgeon Lieut.-Colonel PRINGLE said he should like to say a word, not from the mercantile or commercial point of view, but from having lived in camp amongst the natives and seen districts first where there were no railways, and then seen the effect when railways came, and a very remarkable effect it had. It liberated cattle for working in taking-in land. The prosperity of India really rested on the value of the bullock. The Indian was a cultivator, the bulk of the population lived in villages, and what they wanted was a cheap bullock; given that there was no limit to the development of the country. The secret of the cheap bullock was the extension of light railways, which liberated the cattle that brought produce to market. In every district he had been in the great difficulty of the progress had been the cost of the bullock, and it had risen to such a height lately as to seriously interfere with the bringing of land under cultivation. These light railways could be established very economically, because there was a system of roads over a greater part of the country which would admit of the railway being put by the side of them. He feared the mode adopted in supplying the troops with butcher's meat was terribly against the increase of cattle, and thus diminished the power of the native to take in forest land, owing to the slaughtering of cows in a condition which, while it might seem to favour the interests of the butcher, was fatal to those of the cultivator.

Mr. MARTIN WOOD said he only had two words to offer. First, he wished to remind the meeting that there was another side to this subject than that put before them, and to ask them to hold their judgment in suspense to some extent in the presence of the very general statements made that afternoon. He would mention some of the points to be put on the other side in the *Journal* afterwards. The other matter was with regard to the financial difficulty to which the Chairman had referred. Just at present it required great hardihood to propose anything in the nature of expenditure, and Mr. Walton had spoken of financial timidity. If the Chairman and others would secure a British treasury guarantee for railways they would go ahead.

The CHAIRMAN then put the resolution for the vote of thanks, which was carried unanimously.

Mr. PARRY, in reply, said he felt highly gratifi at the reception which his paper had received. M Benedict asked why companies could not make the railways? The reply was, they could easily made with a guarantee, but the Rutlam-Mutt might be ventured on without a guarantee. I could not follow what Mr. Thornton had said abc the Beloochistan road. There might have been survey somewhere round that coast, but he was n aware of it in his time.

Mr. THORNTON said it was made by Colon Holdich and others about three years ago, ar Major Scott made the railway survey up the Zh Valley.

Mr. PARRY said he believed the survey referred t was a trigonometrical survey, not a railway surve The Zhob Valley Railway survey, made under Maj Scott, traversed a very difficult country, and was ve expensive. It was a purely military line. It wou cost at least £4,000,000 to make, and would nev pay its working expenses.

Mr. W. S. SETON-KARR writes:—Having listene attentively to Mr. Parry's paper on railways and t the Chairman and other speakers, I should like t add a few words in writing. With reference to th remarks on the apparent reluctance of the Govern ment of India to extend railways in India, it shoul be remembered that financial and other main con siderations cannot be hastily put on one side. As matter of fact, the Indian railway system was treate with marked generosity in 1854-5, during the admin istration of Lord Dalhousie, and when Lord Halifax then Sir Charles Wood, was President of the Boar of Control. Had it not been for his guarantee o 5 per cent. interest on all capital employed, an before the works were completed, it may be doubte whether we should have had railways at all. And i must not be forgotten that whereas, in the time c Lord Mayo, there were only, roundly speaking, som 6,000 miles of railway opened in India, the total i 1893 was a mileage of over 18,000. Nearly th whole of the capital invested in this property ha been supplied by Englishmen. Natives have gene rally been backward in their support. Again, i should be noted that new branches of railway canno lead to any direct or perceptible increase in the lan revenue. In three large provinces now traversed b railways the land tax or land revenue levied by th Government is fixed in perpetuity. In others Settlement has been concluded for a term of years and it cannot be revised or altered until the tim expires. Railways, of course, may, as has bee stated in this discussion, pay dividends of 5 or 6 pe cent., and indirectly they can contribute to th wealth and prosperity of the people. They will als in some cases lead to an enhancement of the rent c the landlord as distinguished from the revenue c Government. And rapid and easy communication

ver to remove superabundant produce from rich oor districts, security against famine and scarcity, easy transport of troops, and greater facilities for administration in all its branches; all these things obviously be of immeasurable advantage to the nmunity and the State. But it must not be forten that taxation in India has, in the opinion of erts, reached its utmost limits, and that undue or ra pressure on the native taxpayer would bring ut results from which the most experienced ninistrator naturally shrinks. If members will y consult the Minutes of evidence taken by the Opium Commission, they will see that, when eral witnesses were pressed to say what form of ation in India might be substituted for the six or en millions derived from opium, they had either hing to offer, or else made suggestions absurd and practicable. The extension of railways in suitable ces all over India is simply a question of time; finance is the main element of consideration in all h cases. And without going into the question of netallism, it is impossible not to recognise the fact it the fall of the rupee involves additional demands the part of Government from the Indian taxpayer some three or four millions a year.

Mr. W. MARTIN WOOD writes:—We all agree at India affords scope for more railways, though it not easy for those who are familiar with the ysical geography of the great peninsula to see w and where Mr. Walton's grand scheme of ,000 more miles could be applied. Comparisons tween India and the United States for this purse are delusive and worse than useless. The vantage of Mr. Parry's paper is that it does ecify comparisons within India itself, and these fer definite bases to which practical tests may be plied. Several of the routes that he set out, if ey not quite overlap, do compete with or must be garded as rivals of others that are more advanced in mewhat similar directions. For instance, though seemed to make out a strong case for the ambious scheme to connect Benares with the Bay of engal, through the Palamow coalfield, it would be far more practical course to let the Bengal and agpur carry its line through to the coast at Kuttak. s to the conflicting projects that converge on otri, on the left bank of the Indus, it is difficult see how they could be made to pay after the normous work of bridging the Indus at that place. f from Kotri the Indus could be canalised to the a, then that might be achieved, though the long arren land through the Rajputana desert forbids the ope of local traffic. This serves to illustrate and mphasise a question of principle that underlies the allacy of the ironmasters' panacea—nothing like railways for India. We cannot do everything at once; ndia wants other public works beside railways. She eeds far more water storage and waterways: the ormer to create crops to be carried, and the latter to carry bulky products, at as low a cost as possible, to and from the sea. Then, to take a more immediately practical point of the problem—which was justly dealt with—the existing through lines require to be supplemented with feeder lines, constructed on strictly economical plans. To this end rupee capital might be attracted with local five per cent. guarantees, given by the existing companies. Our railmakers and locomotive builders could do very much to work out this detailed part of the problem of cheap transit; but they do not seem inclined to devote to it that painstaking effort which is required. Let them try their hands at that in the intervals of their clamouring for help from the overburdened Jupiter of Indian finance.

TWENTIETH ORDINARY MEETING.

Wednesday, May 8, 1895; JOHN WOLFE BARRY, C.B., Member of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Adams, Walter, 64, Watling-street, E.C.
Fremantle, Hon. Sir Charles W., K.C.B., 10, Sloane-gardens, S.W.
Lethbridge, Sir Roper, K.C.I.E., Lynsted-lodge, Lynsted, Sittingbourne.
Rawlings, John Joseph, 18, Earl's-court-gardens, South Kensington, S.W.

The following candidates were balloted for and duly elected members of the Society.

Brown, Arthur Crompton, The Laurels, Chesterfield.
Crampton, W. T., Parcmont, Roundhay, near Leeds.
Jenkins, John H. B., Great Eastern Railway Works, Stratford, E.
Jennings, Gilbert D., 28, Gracechurch-street, E.C.
Luty, Arthur, 30, Bryn-mor-terrace, Swansea.
McDonald, John, Charters Towers, Queensland, and 43, Threadneedle-street, E.C.
Markoff, Dr. Anatolius Vladimirovich, 51, Hunter-street, Brunswick-square, W.C.
Molyneux, Harry, The Kennels, Haines-hill, Twyford, Berks.
Norman, John Thomas, 78, Chelverton-road, Putney, S.W.
Penny, John A., 16, Wallace-road, Canonbury, N.

The paper read was—

THE REDUCTION OF THE RARER METALS FROM THEIR OXIDES.

BY PROFESSOR W. C. ROBERTS-AUSTEN, C.B., F.R.S.

My communication can hardly be dignified by the name of a paper, but I thought that as

the question of the reduction of the rarer metals from their oxides was one which was assuming very great importance, that it might interest the members of the Society if I briefly showed them the methods by which this reduction can be effected.

When a metal is separated from a state of chemical combination it is said to be "reduced," and the process of separation is termed "reduction." For centuries the main agent employed for this purpose was either carbon or the gas carbonic oxide which is produced by its partial oxidation of carbon. Carbon has been used for the reduction of metallic oxides from times of which we have no written history, but the early metallurgists also availed themselves of a complex series of reactions which take place when metallic oxides are heated with metallic sulphides, without, however, understanding the nature of the mutual action of these substances on each other. Copper, for instance, must have been so separated from its ores without the direct action of carbon as a reducing agent from very early times, but carbon is still the agent by which reduction is effected in that vast metallurgical appliance, the blast-furnace, used for smelting iron.

There are, however, many metallic oxides which will not part with their oxygen to either carbon or carbonic oxide. Alumina is an instance, its reduction by carbon can only be effected at a very high temperature, aided by the tearing effect of the electric current. At the very high temperatures at which carbon may be vapourized, some 3,600° C., the reducing action of carbon vapour is probably energetic.

The history of the gradual introduction of other reducing agents is very interesting, but it will only be incidentally touched upon in order to make the nature of modern operations clearer than it otherwise would be.

At the beginning of the century, it became evident that metals might be used at high temperatures as reducing agents. Thus, in 1809, Davy, Gay-Lussac, and Thenard obtained the metals of the alkalies, and it was soon found that metallic potassium and sodium was a powerful weapon for separating oxygen from other metals. It often happened that the chloride was operated upon with the alkali metal; thus Berzelius obtained the metal yttrium, in the form of a grey powder, by heating its chloride with potassium.

Thus, to take an important case, Wöhler obtained metallic aluminium in 1822 as a grey powder by the action of potassium on al minium chloride; and he afterwards, in 185 obtained it as a white compact metal, u oxidisable in air, and acted on with difficul by acids.

Mosander (1839) obtained metallic lanth num and cerium by heating their chlorid with potassium and sodium respectivel Marignac was the first to prepare metallic didy mium by heating its chloride with potassiu Or, to take another case: Wöhler obtaine crystalline chromium by igniting a mixture anhydrous chromic chloride with finely-divide zinc and sodium and potassium at th boiling point of zinc. Fremy also prepare crystalline chromium by the action of th vapour of sodium on anhydrous chromi chloride in a stream of hydrogen. Uraniu is another metal which was separated by th aid of sodium; for, in 1841, Peligot ignite oxide of uranium UO_2 with charcoal in stream of chlorine. He thus obtained volatil uranium tetrachloride, UCl_4, which, whe heated with sodium, gave metallic uranium a a grey metal.

In 1863, indium was discovered in the Freiberg zinc blendes by Reich and Richter. It is best prepared by fusing the oxide with sodium as Winkler describes ("Journ. Pract. Chem." cii. 273).

I hope at an early day to find time to deal fully with the history of the use of certain metals for the reduction of the oxides of the rarer metals; at present I would only refer to a very interesting paper by H. F. Keller,* who points out that Békétoff used aluminium for the reduction of potassium hydroxide. There can be no question that the cheapening of magnesium and aluminium will have a great influence in metallurgical operations conducted with a view to the extraction of the rarer metals from their oxides, and, as Keller states, Clemens Winkler, of Frieberg, has made a systematic investigation of the reducing action of magnesium upon oxides, while Seubert and Schmidt have conducted a similar investigation as to its action on chlorides.

Among the very early work in this direction on a practical scale must be mentioned that of Green and Wahl, whose patent is dated 11th February, 1893 (No. 82). They obtained manganese and manganese alloys free from carbon, and this freedom from carbon is a point

* "Journal of the American Chemical Society," Dec., 1874, p. 833.

f the utmost importance. Manganese can be educed from its oxides by the action of carbon nd carbonic oxide, but the manganese so btained always contains carbon, and when it ecomes a question of the addition of manganese to a bath of molten steel, the simultaneous introduction of carbon may be a matter of reat moment, as a few hundredths of one per cent. of carbon, in certain varieties of steel, is not to be lightly considered.

At a *soirée* of the Royal Society last year, Mr. Vautin exhibited some very interesting specimens of the rarer metals, which, aided by Mr. Picard, he had himself extracted mainly from their oxides by the use of finely divided aluminium—granulated aluminium, that is—which is obtained by vigorously stirring molten aluminium while it is passing from the fluid to the solid state. Many of the specimens obtained by Mr. Vautin are exhibited to-night. I have obtained certain other specimens, and have employed them in the course of a recently-conducted research.

There are certain experiments connected with the reduction of oxides by aluminium which it may interest you to see. I will therefore describe them.

In this little furnace there is a small crucible, which contains oxide of chromium and aluminium. The temperature is being raised to a point which we have very carefully measured; it is 1,015° C. I might have arranged the experiment with a thermo junction plunged into the mixed mass of aluminium and oxide of chromium, and you would have seen that as soon as a temperature of 1,015° is reached, the aluminium reacts on the metallic chromium. You will see a slight evolution of heat, light, and smoke, and left behind in the crucible will be a little button of chromium. The re-action takes place comparatively quietly, but I think you will be able to see it. It requires a certain initial temperature for the aluminium to act on the oxide of chromium, and in this case that temperature is 1,015°. [The reaction took place quietly, but a shower of sparks was projected from the crucible.] We will break open the crucible presently, and there will be a little button of chromium left behind.

Now I will perform another experiment, I will take a little oxide of lead and metallic aluminium. Oxide of lead is very easily reduced; oxide of chromium is very difficult to reduce, as you have already seen. Oxide of lead in two minutes will be reduced with something approaching explosion. It is not at all an easy experiment to arrange, in fact it is very difficult; if you make the charge too large you will blow the furnace to atoms, as we have done on many occasions. The difficulty is to produce a sufficient effect to satisfy you, perfectly free from any risk of danger [explosion took place like a rifle shot], and I am glad to say we have succeeded. The thermal conditions are all in our favour in this experiment; the aluminium reacts with great readiness on oxide of lead, and resents having so easy a task to perform, and expresses itself in a loud manner.

If you take, instead of oxide of lead, litharge which has been melted and ground up, the reaction is smaller, and explodes very much like a squib. When it is a case of a very difficult reducible oxide the reaction takes place in a much more gentle manner. You may have variations from violent explosions, which will shiver the furnace, to the slow, gradual action of some of the more difficult oxidisable materials.

I now come to another totally different method of obtaining the rarer metals from their oxides, and the development of this method we owe to the distinguished French chemist, M. Moisson. He has pointed out that metallurgists have recently employed currents of high tension for the electrolysis of metallic compounds. The new method of preparing aluminium and magnesium are cases in point. The heat furnished by the electric arc can, moreover, be used in the reduction by carbon of certain oxides which have hitherto been considered to be irriducible. The great merit of Moisson's work consists in the fact that he has separated the heat action of the arc from the electrolytic action. He makes the heat reverberate on to the substance to be reduced, and, by the use of currents of 400 ampères and 60 volts, he has given us a remarkable series of metals, usually, however, associated with carbon.

You almost always get carbides of the metals by this method. By placing oxide of uranium U_3O_4 in the electrical furnace, and passing a current of 450 ampères and 60 volts, Moisson obtained uranium containing 5 to 13 per cent. of carbon. From oxide of manganese, using 300 ampères and 60 volts, he obtained carbides of manganese containing 6 to 14 per cent. of carbon. From chromium oxide Cr_2O_3, using 350 ampères or 50 volts, or even less, he obtained carbides of chromium containing 8·6 to 12·85 per cent. of carbon. Zircon

when treated in the electrical furnace, using 360 ampères and 60 volts, yields either carbon—free zircomium or a carbide containing 4 to 5 per cent. of carbon according to whether you take a small or a large supply of zircon to reduce. Again, tungsten, from tungsten acid, using 350 ampères and 70 volts, you get either carbon, free tungsten, or carbides, with it may be as much as 18 per cent. of carbon; but you can easily get tungsten carbon free by melting the carbide with excess of oxide. Molybdenum is obtained by calcining molybdate of ammonia, using 350 ampères and 70 volts; you get a very hard carbide, containing about 9·88 per cent. of carbon. Oxide of vanadium is obtained by calcining a salt of vanadium. You get carbides rich in carbon, containing 17 to 25 per cent. of carbon. In that way he has given us practically all the rare metals.

I cannot do better than project on the screen the interior of the furnace, not, however, using it for the reduction of metallic oxides, because if I did that you would practically see nothing unless you waited for some twenty minutes. I prefer to melt up some chromium, and we will project the image of the fluid mass on the screen. Chromium is a very difficult thing to melt. Over a hole in the cover of the furnace is a mirror, and a lens so arranged that the light coming up will be reflected on the mirror and thrown on the screen. You now see the poles and the base of the furnace. You are looking down into the furnace as if you were standing over it. The chromium is hanging a little to the side, but it will gradually melt down. The arc is not passing straight from pole to pole, but is deflected down by a magnet.

You can measure the temperature in this way, by detaching a piece of the carbon pole, and dropping it quickly in water. You thus find out how much heat is transferred to the water, and in that way you can estimate the temperature. Subsequently you can so determine the temperature which has been attained in the furnace itself. Speaking from previous results, I know the temperature in the furnace before you now cannot be less than 2,500° C., and probably it is a little higher.

I will now melt some wrought-iron nails, which you will see will run down very soon.

[The experiment was then performed.]

I was right in insisting upon the fact that I have not dignified this brief communication by the title of a "Paper," but the experiments are so very beautiful that I could not refrain from showing them to the members. Of t uses of the metal now that we have the it is impossible to say very much, but I ne only remind you of the extraordinary impo ance in armour plates and projectiles t introduction of the metal chromium or nick in small quantities, to show that these m have an important future. With apologi for the brevity of this communication, that my case.

DISCUSSION.

The CHAIRMAN said he was sure that he shou only be interpreting the sentiments of those prese in proposing a hearty vote of thanks to Profes Roberts-Austen for his very charming paper and for t beautiful experiments which they had the privilege seeing. In a country like this, the basis of wh prosperity might almost be said to rest on met lurgy and the application of metals, the matters t had been brought before them that evening w evidently of primary importance. In saying that rested on a metallic basis, he did not wish to understood as in any way to be alluding to t thorny subject of bi-metallism, about which he su posed they might argue for three days and thr nights and never come to an end of the subject, b he alluded to those applications of metals to co merce and the manufactures of this country up which it was no hyperbole to say that the prosper of this country depended. The matters broug before them that evening were interesting not mer to those who made a study of metallurgy, but to t whole of the country, in fact the whole of the wor especially their own country. Most persons alrea dimly saw the great future which was bef aluminium, and large works were being started produce it in commercial quantities. Every o would watch this experiment with great intere One could not help seeing that we were only on t threshold of discovering other metals of perha more utility than aluminium, the future of which one could possibly prognosticate. In conclusi he begged to propose a cordial vote of than to Professor Roberts-Austen for his interesti paper.

Mr. C. T. J. VAUTIN said he was glad of the opp tunity of referring to the reduction of oxides means of heat generated by electric energy, and co not do so without referring to Siemens. Sieme as was stated in every text-book, had described electric furnace in which one pole was at the bott and the other at the top, and with that furnace witnessed in Melbourne, some ten years ago, the p duction of nearly every one of the carbides, or co binations of metals in carbon, which the illustri French chemist Moisson had since produced. It

wing what had been done in a quiet way by a leman who, he regretted to say, never published hing at all, Mr. Newbury, with whom he fortunate in being associated, and after Mr. sson started his work he determined himself, if ible, to try and produce some of the metals from carbon. These results were obtained to a t extent in consequence of being able to obtain ninium in a finely divided form, and this was only e after several mechanical means had been tried failed. It was through Mr. Pickard's energy research that they were able to obtain aluminium a form most suited for reduction. So far as omium was concerned, very large quantities e now being daily produced in Germany, much as 4 or 5 cwts. at one casting, con- ing as little as $\frac{1}{4}$ per cent. of aluminium and $\frac{1}{2}$ per cent. of silicon. It was hoped that even small quantity of silicon would be reduced by ting purer magnesia to work with. They were v producing alloys of calcium and iron containing per cent. of calcium, and with these alloys experi- nts were being made for the purpose of desul- rising iron; and from results which had been nmunicated to him, though not from his own eriments, he believed there might be some com- rcial application for such an alloy. Referring ce more to the splendid work of M. Moisson, he l the pleasure in Paris of looking at a number of products, and the only thing which struck n there as being against the electrolytic thod was its great cost as compared with method of reduction by means of aluminium, ich could now be obtained at as low a price as narks per kilo—upwards of 99 per cent. as it was oduced at the Nordhausen works. Aluminium luced with the greatest ease sodic oxide, calcic ide, and barium oxide. On the other hand, by no thod he had heard of could they induce sodium to luce alumina, and he thought it was doubtful lether potassium reduced alumina *per se*. On the her hand, the oxides of potassium and sodium uld be reduced with the greatest ease by means of ıminium. There were some curious facts in con- ction with these reductions which were hardly ted for that evening's discussion, but he hoped to ve an opportunity some other time of bringing em forward.

Mr. H. C. JENKINS said that some year or two ago r. Ball and himself, looking at the problem of the sulphurisation of iron, came to the conclusion that e metal calcium was the important agent in desul- ıurisation by means of calcium chloride, and it curred to them, Why not put calcium in as a etal or as a carbide? By the kindness of Pro- ssor Roberts-Austen, one or two experiments ere tried, but it was soon found that the cost would, ıder existing conditions, be too great, and the atter was dropped; but there was no doubt the lcium did take out the sulphur. He was glad to hear that Mr. Vautin had managed to obtain in a very easy way an alloy with the iron itself, which might lead to some great development in the future.

Mr. B. KITTO said he had listened with very great pleasure to the paper, but he had hoped to hear more about the reduction of the rarer metals by means of aluminium, as introduced to the world by the labours of Mr. Vautin. He had himself been more particularly interested in uranium, and had spent a good deal of time in endeavouring to obtain that metal from its compounds. Professor Roberts-Austen had told them that the metal had been obtained by acting on the chloride with metallic sodium; but he must say that, having tried that method, he had failed. Knowing that Mr. Vautin had been very successful in reducing such oxides of the metal chromium, and others equally refractory, he mentioned his work to him, and asked him to be good enough to try the oxide of uranium. He prepared some of the oxide in a particular form, which, he understood, was used by Moisson, and took it to Mr. Vautin's laboratory, and Mr. Pickard—by whom he believed a great deal of the work had been done—treated it with specially prepared aluminium, and succeeded in getting a button of alloy the size of a pea. Upon analysing it, he found it yielded 62·63 of uranium, about 35 per cent. of aluminium, and the remainder, he believed, was silicon. He was very anxious to hear whether Prof. Roberts-Austen had succeeded in getting that particular metal in a pure form, and also whether he had tried any of the other oxides—for instance, U_3O_8—and if so, what success he had achieved by means of the granulated aluminium, as suggested by Mr. Vautin and Mr. Pickard.

Mr. ROGER WALLACE said he should like to say a few words in praise of the work that Mr. Roberts-Austen had been doing in connection with the rarer metals. The new use which had been pointed out for aluminium, in the reduction of other metals, was a factor of very great importance in the future of metallurgy. With regard to the manufacture of aluminium in this country, he was pleased to say that the British Aluminium Company were now about to place this industry in its proper position, as far as Great Britain was concerned. In the past, aluminium had been manufactured in this country by the chemical processes, but those processes had been altogether surpassed by the electrical process. The last he heard of chemical processes was when Mr. Vautin had produced, with very great industry and research, a sulphide of aluminium. He hoped for great things from that, but up to the present he had not heard that Mr. Vautin had been able to reduce that sulphide. The company he had mentioned would soon be able to manufacture aluminium in Great Britain in the same way as it was produced in Nordhausen, and probably better, because, having the bauxite mines in Ireland, and

water-power in Scotland they would have every natural facility for success. In fact, they would be giving a new industry to Scotland, and also to Ireland, in the manufacture of aluminium from bauxite. He was glad to hear that Professor Roberts-Austen had a new use for aluminium, and felt that this furnace had a great future before it. Everyone who had to do with chemistry knew that there was a very large future in the application of metals which, up to the present, had hardly been used at all. They saw it in the incandescent gas lighting, and in alloys of various metals, and this last use would probably be of very great importance. They knew that one of the great drawbacks to the use of aluminium had been its want of tensile strength, but there was little doubt that the addition of a very small per-centage of some of these rarer metals which had hitherto been beyond practical use, would enormously increase its tensile strength.

Mr. PICKARD said he might reply to Mr. Kitto's question by saying that in all probability the reason they got an alloy of uranium and aluminium containing so much as 30 per cent. of the latter metal, was simply that they added too much aluminium for the purpose of reduction. It was not a simple matter to calculate exactly in the case of uranium, because they did not know the exact formula of its oxides, and they varied very much. The oxide of uranium, U_3O_8 they had not yet been able to analyse, but they had reason to believe it was very pure. Mr. Kitto had spoken very kindly of his part of the work, but he must say the whole merit of the discovery was due to Mr. Vautin.

The vote of thanks having been put and carried,

Professor ROBERTS-AUSTEN said he had not specially dealt with all the beautiful specimens on the table, but had only taken up two at random, the magnificent mass of manganese carbon free, and the equally fine fragment of a larger mass of chromium which he handed to the Chairman as perhaps the most remarkable metallurgical specimen he had ever seen, both of which were produced by Mr. Vautin. On the table were also carbon-free tungsten, the only mass he had ever seen, uranium, and some molybdenum which Mr. Pickard produced at the Mint with him. There could be no question that a most important field was opening, and the cheapening of aluminium, to which Mr. Wallace referred, could not fail to play a most important part in metallurgy, by enabling them to get these rarer metals, and to add them to masses of their common associates, the effect of which was, in many cases, most remarkable. For instance, take the case of titanium, that would be most useful. When the Naval Architects met in that room very recently, reference was made to the difficulty in the use of aluminium for torpedo boats on account of the boats corroding on the line between wind and water. He knew an instance where a yacht was built f[or] a French proprietor who was very well pleas[ed] with it until he moored it with an iron cha[in] to an iron post, to which post was also moor[ed] a boat sheathed with copper. The result w[as] that a gigantic battery was established, and t[he] aluminium yacht was found to be dissolving awa[y]. The addition of ·2 per cent. of titanium i[n]creased the durability of such a metal as aluminiu[m] when subject to the solvent action of salt water. [It] was impossible to say what might happen when th[ey] had studied the properties of alloys containing minu[te] quantities of the rarer metals. He hardly dar[ed] mention their uses in connection with electricit[y]; "platinoid" and "manganive" had already attract[ed] attention, and it was impossible to say what valuab[le] results might be obtained. Mr. Kitto's questi[on] had been answered by Mr. Pickard, of whose wor[k] as an old student of his own, he was naturally prou[d].

Miscellaneous.

BANANA MEAL AND ITS FUTURE PROSPECTS.

A good deal of attention has been drawn of la[te] to the use of the banana as a source of flour or mea[l], and though such an application is by no means nev[w] or the discovery modern, it seems not at all unlikel[y] that banana flour is an article that has a prospect of great development in the near future. Wherever th[e] banana or plantain thrive, the fruits, when dry, ar[e] converted into meal, and used for making cake[s], puddings, and for various other uses in cooker[y]. This has been very fully treated of in the *Ke[w] Bulletin* for August, 1894, where a recent analysi[s] by Prof. Church is given. Attention is also draw[n] to the following extract from a report on th[e] exhibits sent from Jamaica to the Chicago Exhibitio[n] in 1893:—"The banana meal engaged the carefu[l] attention of several of the leading grocers in Chicag[o] and elsewhere. One large house in Chicago—Sprague, Warner, and Co.—after testing samples o[f] this meal, was so pleased with the result that [it] offered to undertake to introduce it as a food f[or] infants and invalids, provided the producers woul[d] guarantee to supply the necessary amount t[o] advertise it extensively in the United States. Messr[s]. Sprague, Warner, and Co. estimated that a sum o[f] not less than $25,000 would be necessary to launc[h] this new product on the American market, an[d] unless this sum were forthcoming they did not se[e] their way to dealing with it, on the ground that n[o] sales in any quantity could be expected. This pro-posal was in due course submitted to the exhibitor[s] whose meal had been experimented upon; bu[t] unfortunately, those gentlemen were unable at th[e] time to adopt the course proposed, and the matter i[s]

ll in abeyance." The Commissioner concludes s report by saying, "I am strongly of opinion that th a judicious outlay of capital, and with a reasonle certainty that no sudden changes will be made tariff regulations, there is a market open for nana meal in the United States." Since the date this report it has been proposed to establish a ctory for the preparation of the meal in Jamaica, ıich it is estimated could be made remunerative if supply of the small bunches of bananas could be tained at the rate of 7d. per 100 pounds, including e stalk. The Director of Public Gardens in maica, however, after communicating with several anters, found that the general opinion was that the ice mentioned would not pay them to supply their ıall and unsaleable bunches at the above rate, so at the question of the manufacture of banana meal a large scale in Jamaica seems at present in eyance. Some notes on the use of banana meal brewing are given in the *Bulletin* of the otanical Department of Jamaica, for July last, which n as follows:—Mr. Kahlke, one of the best known anufacturers of yeast in Germany, writes in this conction, "Banana flour without doubt, from its richss in starch and its good flavour, is particularly itable for the manufacture of yeast. This flour is sily rendered saccharine. The yeast obtained by lding banana flour to the other ingredients has a od colour, all the requisite properties of an excelnt class of yeast, and moreover keeps well. The cohol obtained from it leaves nothing to be desired, that this flour may be introduced as an article of mmerce, and employed without any special preıration. Satisfactory experiments have also been ade in some breweries, where 20 per cent. of malt as been replaced by the flakes and flour of bananas. he flavour of beer was not altered, and the quantity liquid was increased, and the malt was replaced a less expensive substance. Experiments are ing made in which the proportion of banana flour increased." One of the great Belgian brewers rites:—"These flakes are macerated in the vat ith the malt, and the result was much superior to ıat of maize, the drainage of the mixture was a little ifficult at first, but after being stirred a second time ıe draining proceeded rapidly; briefly the use of the akes may be considered both advantageous and easy brewing." Different banana flours, and notably ıat prepared specially for the manufacture of glucose, ave been tried in some *glucoseries*. Although diffiılties were met with in the manufacture principally ith respect to discolouration, it has been shown that ıe glucose obtained from it has a good flavour, is very weet, and slightly aromatic. It is highly probable ıat a special study of the subject will surmount the ight difficulties which at first presented themselves the use of this new product in glucoseries. Very ourishing bread has been made from equal proortions of bananas, and wheat and rye flour, and ven from a mixture of two-thirds of banana and onehird of ordinary flour. A sweet banana flour having an agreeable flavour of the fresh fruit appears to be specially suitable for cakes and biscuits.

THE EARLY HISTORY OF TELEPHONY.

The interest of the subject affords sufficient reason for reprinting, from *The Electrical Engineer*, the following remarks by Prof. D. E. Hughes, F.R.S., at the banquet given by the staff of the National Telephone Company on the 15th March:—

The earliest record of a perfect theoretical electric telephone was contained in Du Moncel's "Exposée des Applications," Paris, 1854; when M. Charles Bourseul, a French telegraphist, conceived a plan of conveying sounds and speech by electricity. Suppose, he explained, "that a man speaks near a movable disc sufficiently flexible to lose none of the vibrations of his voice, that this disc alternately makes and breaks the current from a battery; you may have at a distance another disc which will simultaneously execute the same vibrations." Unfortunately, M. Bourseul did not work out his idea to a practical end, but in these few words we have the shortest possible explanation of the theory of our present telephones.

It is now exactly 30 years since my first experiments with a working telephone, for in 1865, being at St. Petersburg in order to fulfil my contract with the Russian Government for the establishment of my printing telegraph instrument upon all their important lines, I was invited by his Majesty, the Emperor Alexander II., to give a lecture before his Majesty, the Empress, and Court, at Czarskoi Zelo, which I did, but as I wished to present to his Majesty not only my own telegraph instrument, but all the latest novelties, Prof. Philipp Reis, of Friedericksdorf, Frankfort-on-Maine, sent to Russia his new telephone, with which I was enabled to transmit and receive perfectly all musical sounds, and also a few spoken words, though these were rather uncertain, for a few moments a word could be clearly heard, and then from some unexplained cause no words were possible. This wonderful instrnment was based upon the true theory of telephony, and it contained all the necessary organs to make it a practicable success. Its unfortunate inventor died in 1874, almost unknown, poor, and neglected, but the German Government have since tried to make reparation by acknowledging his claims as the first inventor, and erecting a monument to his memory in the cemetery at Friedericksdorf.*

The duties connected with my printing telegraph instrument prevented me from continuing my experiments with the telephone of Prof. Reis; but in 1876, we heard in Europe of the invention by Prof.

* "Philipp Reis, Inventor of the Telephone." A biographical sketch by Prof. Sylvanus P. Thompson, F.R.S., etc., London. E. and F. Spon, 1883.

Alexander Graham Bell of his wonderful telephone, by means of which the practical transmission and reception of human speech had become an accomplished fact, and early in 1877 the instrument was brought to England. I at once resumed my experiments of 1865 with it, and found that Prof. Bell's telephone, considered as a receiver, was absolute perfection, but that his mode of transmission of magneto-electric currents, generated solely by the movement of an iron diaphragm near its electromagnet, was defective, as the currents produced were too feeble for any practical use. I then tried to adopt Prof. Reis's system of using a separate battery, brought into play by the movement of a diaphragm.

I will not cite the numerous experiments and difficulties that I met with in this research; but at last I succeeded in finding the effect I wished, by the use of a very slight electric contact of the surface of solid carbon, or any other metals, such as ordinary iron nails. This slight or microphonic contact has the remarkable power of varying the resistance, and, consequently, the force of an electric current, exactly in accordance with the sonorous vibrations of the human voice; and, in fact, the contacts could easily be rendered so sensitive that the instrument became a true microphone, rendering audible sounds far too feeble for the human ear. All of these results I gave freely to the public, and brought before the notice of the scientific world in a paper I read to the Royal Society in May, 1878.

Another discovery which I made in the continuance of my researches, which is now of the highest utility to far-distant telephony, was the use of twisted wires, or wires so arranged upon their insulators, that the whole line should gradually revolve on its axis, so as to prevent induction from other independent wires. This was given freely to the world in my paper, read before the Society of Telegraph Engineers, March 12, 1879, and fully illustrated by engravings, in *Engineering* of the same week. In order to understand this, I will quote a single paragraph from this paper:—

"If two ordinary aërial lines are thus used, they should have the twist given to these wires, by changing their position relatively to other wires, from vertical to horizontal at each pole or mile. Thus, if we had two lines, A and B, they should have their four relative positions repeated as often as possible—viz., A B, then $\frac{B}{A}$; then B A and $\frac{A}{B}$."

This is the system employed by the telephone line between London and Paris, and, in fact, upon all successful long-distance telephone lines throughout the world; so I think it is only fair that it should be known that I discovered and published this long before long-distance telephony was ever brought into use.

During the same months of 1877 that I was experimenting with Prof. Bell's telephone, Mr. Edison, in the United States, was also engaged upon a similar research—viz., endeavouring to adopt P Reis's method of transmission by a diaphragm separate battery, and he succeeded in inventing patenting his form of transmitter, which he ca the carbon telephone. This transmitter was brou to England in 1878, and it worked remarkably although I felt convinced then, as I am still, that theory upon which it was supposed to work wrong. Mr. Edison's views were that its mod action was based upon the varying resista obtained through a varying pressure of the diaphra upon an elastic button of carbon. (He believed the varying resistance of carbon by pressure was original discovery, but it was well known for m years previous in Europe through its publication Du Moncel, and its application by Clerac in carbon resistance tnbe, whose resistance was var according to the pressure given to its adjust screw.) The error of this theory is shown by the that we cannot obtain more than a difference resistance through pressure upon any conduct substance but of a few ohms, say one to ten, but w a microphonic joint we can easily obtain the wid possible range, from almost zero to an infinity resistance, and this with the smallest possi expenditure of mechanical energy from the diaphra or even without a diaphragm. I believed then, a do still, that its excellent functions were due t microphonic joint, of which, and of the value which, he was unaware, and I also believe that often successful transmission of words by Pr Reis's transmitter was due to an accidental adju ment of his contacts to a true microphonic co dition. He was, of course, unaware of the pow and importance of microphonic joints, else telephone would have been a practical success once.

Unfortunately, Mr. Edison and myself had painful discussion as to priority of invention, which we have both sustained our individual vie up to the present time. Mr. Edison's views ha been sustained by all the companies owning patent; mine have been sustained by nearly whole scientific world. The companies, howev whose interest it was to sustain and possess themselves an entire monopoly, have spared neith wealth nor power to obtain this coveted monopo and by the means of the ablest legal counsel a expert witnesses they obtained a legal decision givi them the sole right to the use of a diaphragm pre ing upon a variable resistance, notwithstanding th the diaphragm was the discovery of Professor R and microphonic contact by myself.

This is all now past history, but I am now mo than consoled by the fact that at the present tim there is not a single transmitter in practical u throughout the world whose function is not bas entirely upon its microphonic joints, whether in t form of solid conductors pressing upon each other, when these contacts are multiplied as in the form granules or powder.

Obituary.

[A]. E. DURHAM, F.R.C.S.—Mr. Arthur Edward [Dur]ham, Consulting-Surgeon to Guy's Hospital, [wh]o died on the 7th inst., was a member of the [Cou]ncil, and a Vice-President of the Royal College [of] Surgeons. He edited the Guy's Hospital Reports [for] some years, and was the author of several works [on] subjects connected with medicines and surgery, [tw]o of his books being entitled "Sleeping and [Dre]aming," and "The Physiology of Sleep." Mr. [Du]rham was elected a member of the Society of [Art]s in 1885.

[E]ARL OF SELBORNE, F.R.S.—The Earl of Sel[bor]ne, who died at his country residence, Blackmoor, [nea]r Petersfield, on the 4th inst., at the age of 82 [yea]rs, was a member of the Society of Arts of some [sta]nding, having been elected in 1863. He took [spe]cial interest in the educational work of the Society, [and] on November 28th, 1866, he presided at an [Ord]inary Meeting, when Mr. W. Hawes read a [pap]er on "Limited Liability in its Relation to [Ma]nufactures and Commerce."

General Notes.

[H]AGUE EXHIBITION OF MEDICINAL AND USE[FU]L PLANTS, 1895.—The Department of Science [an]d Art has received, through the Foreign-office, a [pro]gramme of an Exhibition of Medicinal and Use[ful] Plants which is to be held at the Hague, in July [nex]t. Intending exhibitors should apply (postage [pai]d) for the proper form, which has to be sent in [bef]ore the 15th June, to Dr. M. J. Greshoff, 97, Laan [van] Meerdervort, at the Hague.

[L]UBECK COMMERCIAL AND INDUSTRIAL EXHI[BIT]ION.—Under the patronage of the Senate of [Lu]beck, a German and North-European Exhibition [of] Commerce and Industry is to be held in that town [fro]m the 1st of July to the 30th of September next. [Th]e Exhibition is intended to present a complete [vie]w of the export and import trade between [Ge]rmany and the countries of Northern Europe, [Ru]ssia, Finland, Sweden, Norway, and Denmark, [wit]h the special object of rendering practically useful [the] commercial treaty concluded for a term of ten [yea]rs between Germany and Russia. At the same [tim]e, all raw materials and finished products [exc]hanged by the agency of Germany are admissible. [Th]e United States Consul at Annaberg says that to [ins]ure financial success a guarantee fund of 400,000 [ma]rks has been subscribed by the Government of [Lu]beck, the merchants, and private persons. The [pla]ce selected for the Exhibition is the building site [on] the great water basin of the Wakenitz. The wide range covered by the Exhibition will be seen by the following list of groups:—(1) Mining, founding, and salt works; (2) chemical industry; (3) china, earthenware, and glass goods; (4) agriculture and forestry, with their products, the substances and other auxiliaries employed; dairies, with their machinery and apparatus, and bee keeping; (5) gardening; (6) foods and drinks; (7) tobacco and cigars, and their manufacturing plant; (8) textiles and clothing; (9) wood and wood ware; (10) hardware; (11) metal ware; (12) paper goods; (13) leather and india-rubber goods; (14) architecture and engineering, including designs; (15) ship-building and ship-furnishing; (16) machinery, electro-technics, and means of transportation; (17) graphic arts and industrial designing; (18) scientific instruments; (19) hygiene, sanitary arrangements, fire-extinguishing and life-saving, and public health; (20) musical instruments; (21) education; (22) women's work and home industry; (23) commercial exhibition, raw materials and their utilisation; (24) fishery; (25) sport in all branches.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

MAY 15.—"Means for Mitigating the Fading of Pigments." By CAPTAIN W. DE W. ABNEY, C.B., F.R.S. MAJOR-GENERAL SIR JOHN DONNELLY, K.C.B., Chairman of Council, will preside.

MAY 22.—"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. CHARLETON, A.R.S.M.

INDIAN SECTION.

Thursday Afternoon, at Half-past Four o'clock:—

MAY 23.—"The Northern Balochis; their Customs and Folklore." By OSWALD V. YATES, A.M.Inst. Civil Engineers, late Executive Engineer, Indian Public Works Department.

[Sir James Lyall's paper on "Punjab Irrigation," announced for this date, is unavoidably delayed until next Session.]

FOREIGN AND COLONIAL SECTION.

Tuesday evening, at Eight o'clock:—

MAY 21.—"Commercial Education in Belgium." By PROFESSOR WILLIAM LAYTON. LORD REAY, G.C.S.I., G.C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evening, at Eight o'clock:—

MAY 28.—"The Decoration of St. Paul's." By PROF. W. B. RICHMOND, A.R.A. THE VERY REV. THE DEAN OF ST. PAUL'S will preside.

Cantor Lectures.

Monday Evenings, at Eight o'clock :—

James Douglas, "Recent American methods and appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." Four Lectures.

Lecture IV.—May 13.—*Absorption of the Precious Metals to, and their Separation from, Copper and Lead.*—Argentiferous and auriferous copper mattes—Where chiefly produced—Their treatment and separation by electrolysis and in the wet way—Electrolytic works in the west and on the Atlantic coast—Blue stone manufacture—Ziervogel method as practised at the Argo works of the Boston and Colorado Smelting Company—The John J. Crook method at the Pueblo Smelting Company's works—The Hunt and Douglas process at the Kansas City works—Peculiarities of lead smelting in the United States—Size of smelting furnace—Automatic slag and well taps—Appliances for collecting fumes—The Parkes method and appliances for desilverising lead.

Ernest Hart, D.C.L., "Japanese Art Industries." Two Lectures.

May, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. James Douglas, "Recent American Methods and Appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver." (Lecture IV.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Report by Committee on Mr. Ferranti's paper on the "Electricity Meter and its Evolution." 2. Report on Mr. Ireland's paper on a "Portable Copying Press." 3. Report on Mr. Whitelaw's paper on an "Improved Pump Bucket." 4. Report on Mr. Frazer's paper on a "Graphic Method of Recording Weather Observations." 5. Report on Mr. Blaikie's paper on the "Cosmosphere." 6. "Report on Dr. Turner's paper on the "Spectrum Top." 7. Mr. J. Ciceri Smith, "A Direct Reading Micrometer Wire Gauge." Mr. W. B. Blaikie, "The Retrogradation of the Shadow on the Sun Dial."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. R. E. Middleton, "Village Water Supplies."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Mr. D. G. Hogarth, "A Journey on the Upper Euphrates." 2. Mr. J. L. Myres, "Journeys in the Peninsula of Halicarnassus."

Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, May 14 ... Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Ray Lankester, "Thirty Years' Progress in Biological Science." (Lecture I.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. 1. Mr. A. H. Smith, "The Cyclograph, with illustrations." 2. Mr. Chapman Jones, "The changes that platinum prints are liable to (apparent fading and certain toning processes)."

Anthropological, 3, Hanover-square, W., 8½ p[.m.] Prof. J. Kollmann, "Pygmies in Europ[e]" Mr. W. J. Lewis Abbott, "Notes on a R[em]able Barrow at Sevenoaks ; the Hastings K[itchen] Middens ; and notes on some specialise[d] diminutive forms of Flint Implements [...] Hastings Kitchen Midden and Sevenoaks [...] Mr. R. H. Mathews, "The Rock Paintin[gs and] Carvings of the Australian Aborigines."

Colonial Institute, Whitehall-rooms, Whi[tehall-]place, S.W., 8 p.m. The Rev. J. E. C. W[...] "The Imperial Aspects of Education."

Wednesday, May 15...SOCIETY OF ARTS, John-[street,] Adelphi, W.C., 8 p.m. Captain W. de W. [...] "Means for Mitigating the Fading of Pigm[ents]"

Meteorological, 12, Great George-street, S.[W., 7½] p.m. 1. Messrs. G. J. Symons and G. Chat[...] "The November Floods of 1894 in the T[hames] Valley." 2. Mr. F. J. Brodie, "Barom[etric] Changes preceding and accompanying the [...] Rainfall of 1894."

Geological, Burlington-house, W., 8 p.m. Mr. Horace W. Monckton, "The S[...] Dolerite." 2. Mr. J. Postlethwaite, "No[tes on] some Railway Cuttings near Keswick." [...] Dugald Bell, "The Shelly Clays and Gra[vels of] Aberdeenshire considered in relation t[o the] question of Submergence."

Microscopical, 20, Hanover-square, W., 8 p.[m.] Mr. W. C. Bosanquet, "The Anatom[y of] *Nyclotherus ovalis.*" 2. Dr. A. Bruce, "A[...] Microtome for Cutting." 3. Miss Ethel Sa[...] "Some Details of the First Nuclear Divis[ion in] the Pollen-mother Cells of *Lilium martagon*"

Archæological Association, 32, Sackville-stree[t, W.,] 8 p.m.

United Service Institution, Whitehall-yard, [...] 3 p.m. Dr. Macdonald, "Naval Hygiene."

Photographic Club, Anderton's Hotel, Fleet-s[treet,] E.C., 8 p.m. Mr. W. D. Walford, "Photog[raphy] and Cycling."

Institute of Mining and Metallurgy, Geol[ogical] Museum, Jermyn-street, S.W., 8 p.m. Mr. [...] James, "Cyanide Practice."

Botanic Gardens, Regent's-park, N.W., 2[...] Summer Exhibition.

Thursday, May 16...Royal, Burlington-house, W., 4½ p[.m.]

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. 1. [...] Bernard Dyer, "Kjeldahl's Process for the [De-]termination of Nitrogen." 2. Profs. Meldol[a and] E. R. Andrews, "The Action of Nitrous Ac[id on] 1:4:2 Dibromaniline." 3. Prof. Dixon an[d] Doran, "Derivatives of Succinyl and Ph[...] Dithiocarbimides."

Society for the Encouragement of Fine Arts, 9, [Con-]duit-street, W., 8 p.m. Mrs. Salwey, "Th[e Art] of Metal Working in Japan."

Royal Institution, Albemarle-street, W., 3 [p.m.] Prof. Dewar, "The Liquefaction of Gases." [(Lec-]ture IV.)

Historical, 20, Hanover-square, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Friday, May 17...Royal Institution, Albemarle-street, [W.,] 8 p.m., Weekly Meeting, 9 p.m. Prof. W[...] Rayleigh, "Robert Louis Stevenson."

Queckett Microscopical Club, 20, Hanover-sq[uare,] W.C., 8 p.m.

Saturday, May 18...Sanitary Institute, 74a, Margaret-s[treet,] W., 8 p.m. Dr. B. Armingson, "Infec[tious] Diseases and Methods of Inspection."

Royal Institution, Albemarle-street, W., 3 p.m. [...] Seymour Lucas, "Picture Making." (Lectu[re ...])

Journal of the Society of Arts.

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FRIDAY, MAY 17, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* will be held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education) on Wednesday evening, June 19th.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this each member will be able to purchase not more than two transferable tickets, the price of which will be 5s. each. It is requested that gentlemen requiring these additional tickets will make early application for them. Every application must be accompanied by a remittance.

CANTOR LECTURES.

Mr. James Douglas delivered the fourth and last lecture of his course on "Recent American Methods and Appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver," on Monday evening, 13th inst.

On the motion of the Chairman, a vote of thanks was passed to the lecturer.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 15, 1895; Major-Gen. Sir John Donnelly, K.C.B., Chairman of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Clarke, S. E. J., Bengal Chamber of Commerce, Calcutta, India.
Lilley, Frederick William, care of Eastern Telegraph Company, 50, Old Broad-street, E.C.
Pullman, Arthur, Stalheim, Godalming, Surrey.
Yates, Oswald Vavasour, Wellbank, Sandbach, Cheshire.

The following candidates were balloted for and duly elected members of the Society.

Richey, Sir James Bellett, K.C.I.E., C.S.I., Briers, Byfleet, Surrey.
Thompson, Robert William, Kotri-Rohri State Railway, Hyderabad, Sind, India.

The paper read was—

MEANS FOR MITIGATING THE FADING OF PIGMENTS.

By Captain W. de W. Abney, C.B., F.R.S.

It is not my intention to-night to enter into the causes of the fading of pigments, whether water colour or other. Were I to do so, I should have to keep the meeting considerably longer than either they or myself would consider desirable. I think I must take it for granted that the conclusions Dr. Russell and myself arrived at in 1888 (the date when we made our report to Parliament) have not been controverted or whittled away and may be accepted as correct. I must however quote two of the concluding paragraphs:—"It may be said that every pigment is permanent when exposed to light 'in vacuo,' and this indicates the direction in which experiments should be made for the preservation of water-colour drawings;" and "our experiments also show that the rays which produce by far the greatest change in a pigment are the blue and violet components of white light; and that these, for equal illumination, predominate in light from the sky, whilst they are least in sunlight, and in diffused cloudlight, and are present, in comparatively small proportions, in the artificial lights usually employed in lighting a room or gallery."

At the end of the report we make some reference to glazing the sky-light with yellow glass, and point out that it would be inexpedient to do so, as, although the safety of the pigment's colours would be thereby ensured, or at all events be made more certain, yet in such a light the hues of the blue pigments would suffer to the eye.

The first method of preserving the colour of pictures by placing them in vacuo has been experimented upon by a company, and it would not become me to say what success they have

attained in this direction. The method that I have adopted to minimise fading has been in the direction of controlling the kind of light admitted to the pigments. The point from which I started was from the results of the experiments made as to the fading of different pigments under coloured glasses. The glasses employed were red, green, and blue, which are approximately the three primary colours, and it may be instructive to show you the rays which these three glasses allow to pass. If in front of the slit of the spectroscope a piece of red glass is placed we see that the spectrum is deprived of all the green and blue rays, only red, orange, and a few yellow rays being transmitted. With the green glass the red rays are almost altogether absent, as are al the violet, but the green rays are strong, : are the blue-green, and there is a fair pr portion of yellow and blue rays passing.

Through the blue glass the violet and blue ra pass readily, the green and yellow and red a cut off, though there are two faint bands appa ent in the yellow-green, and in the red. will be noticed that practically these glass divide the spectrum into three parts, (1) tl violet and blue, (2) the green and yellow, ar (3) the orange and red. The following Tab shows how little action takes place under ar glass except the blue, and our statement th: the greatest fading in white light is caused l the violet and blue rays is founded on it.

	White.	Blue.	Green.	Red.
Purple Madder	Faded to 2	Faded to 1	—	—
Antwerp Blue	No experiment	Faded	—	—
Leitches Blue	Sl. faded	Sl. faded	Darkened	Darkened.
Violet Carmine	Faded to 1	Faded to 1	—	—
Paynes Grey	Faded to 1	Bluer	Blue	—
Indigo	No experiment	Faded to 1	—	Sl. faded.
Prussian Blue	No experiment	Sl. faded	—	V. sl. faded.
Rose Madder (2 experiments)	Sl. bleached	Sl. faded	—	—
Brown Pink	No experiment	Faded to 3	—	—
Crimson Lake	No experiment	Faded	Sl. faded	Sl. faded.
Vandyke Brown	No experiment	Faded to 1	Sl. faded	—
Vermilion	Darkened	V. sl. darkened	—	—
Carmine	No experiment	Faded to 3	Sl. faded	—
Gamboge	No experiment	Faded to 1	—	—
Indian Yellow	No experiment	No change	—	—
Sepia	Become lighter	Become lighter	—	—
Burnt Sienna	No change	No change	—	—

Other experiments have shown me that the violet rays are the most active in producing fading, as they are also in producing an ordinary photographic image. If we can eliminate the majority of these rays from white light without appreciably altering the freshness of the colours viewed in such light, we shall practically have prolonged the life of a picture. At first sight that these conditions can obtain may appear problematical; but I trust that you will agree with me shortly, that we can cut off some of these rays without injuring the hue of the colour.

Now, I must ask you to take it from me from a series of experiments made, that ultra marine is that pigment whose dominant colou is nearest to the violet end of the spectrum; an when I say dominant colour, I mean a colou which has approximarely the same colour a a spectrum colour, though it may be mixe with white light to a variable amount.

We can show the dominant colour of som pigments. For instance, here is an orang pigment: I can match that in the spectrur by one orange ray. Emerald green I too ca match, but we must have a certain amount c

hite light mixed with it. Pure ultra-marine, too, we shall see, has a dominant wave-length well below the G Fraunhofer-line. It therefore follows that if we illuminate all pigments with a compound light, in which this ultramarine spectrum colour is included, they must appear appreciably the same as they do in white light,

I must guard myself, however. Do not let us suppose for one instant that these dominant colours are alone those that are reflected from the pigment. They reflect a good many more. We can show that this the case. I place a pigment in the patch of monochromatic light from the spectrum, which can be changed at will, and, the more luminous the pigment appears in any particular colour, the more of that particular light we know is reflected. Thus we place emerald green in the patch and we see that it reflects but little red, more yellow, a maximum in green, and a very little blue. We also find that vermilion reflects a maximum in the red, very little yellow, and practically nothing else. Ultramarine, we find, reflects a very little red, no yellow, a very little green, plenty of blue, and some violet. If we cut off the violet from the spectrum and place the ultramarine in it we shall, however, find the colour appreciably the same it was when the violet was present.

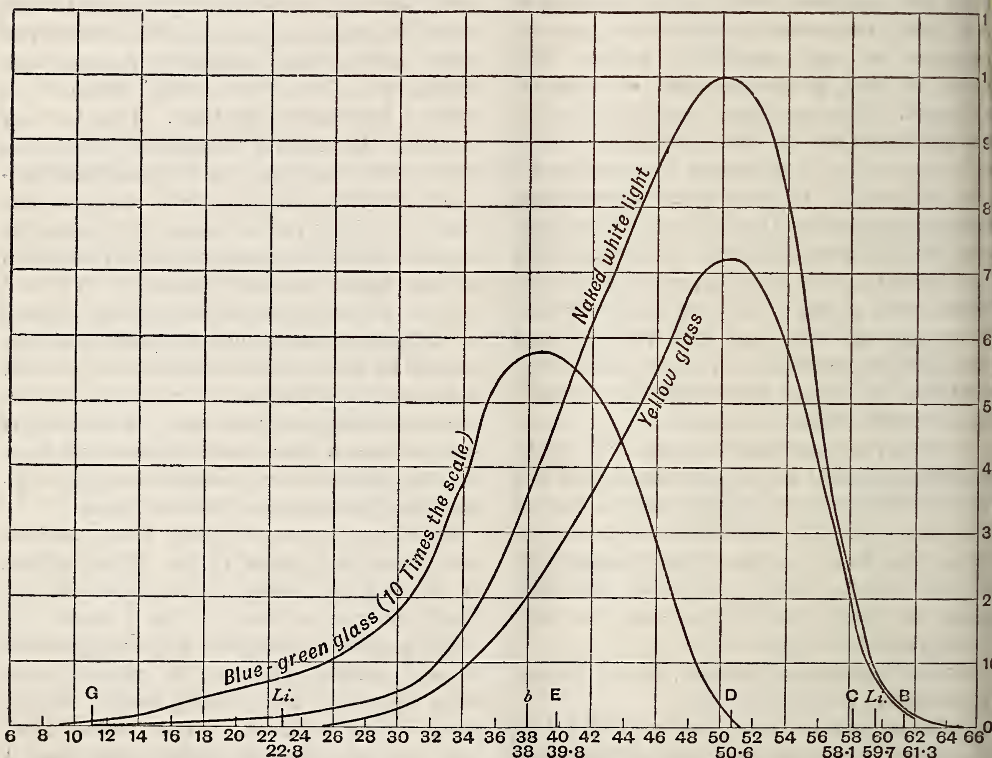
A variety of experiments made with these different pigments tell us that the loss of the violet of the spectrum is practically no loss at all. Even with white light the loss is unnoticeable. If we form a patch of light composed of all the colours except the violet, we shall notice but very little change from the pure white which is alongside of it.

Having established this fact, we are now in a position to go a step further.

In the apparatus I have here at hand, I can place three slits in the spectrum, and by means of a convex lens of proper focal length and curvature, I can cause these colours to recombine and form a patch of white light, being an image of the prism. The slits are now in the spectrum, and a patch of pure white light alongside. I alter the width of the slits till they show the patch of the same colour as the comparison white. The colours are red, green, and blue. Now the red and the green themselves, when mixed, form a yellow, and this can be demonstrated by covering up the slit through which the blue issues —you will see a yellow patch on the screen—evidently, then, since red and green make yellow, a yellow and a blue will form white light. To prove this further, I place a slit in the yellow, and another in the blue, and we have white again formed. As a matter of fact, with any kind of yellow and any kind of blue there is always some blue ray and some yellow ray which will form white light with them respectively by their mixture. But it does not follow that such a white light is a proper one in which to view coloured pigments. For instance, in this mixture of blue and yellow of the spectrum I place an orange, you see it appears yellow; or if I place a green in it it appears whitish, and so on. I might multiply my experiments in this direction, but they would only prove that there must be something beyond a mere match of white light to make it effective as a pigment illuminant. That "something beyond" is really a continuous spectrum. That is every ray must be present except the violet rays, which have heen shown to be practically useless for giving illumination (I may mention that the yellow ray has about 200 times the illumination of the strongest violet ray, which we can spare without detriment). Where a portion of the spectrum is altogether absent or deficient those pigments whose dominant colours lie where these deficiencies are to be found must inevitably alter in hue, just as we found to be the case just now. If we can get a yellow and a blue which together will have such a spectrum when combined together we shall have accomplished what we want.

Now here is a green-blue glass, such is used for ordinary ships' lights. When placed in a beam of white ray, a place in the spectrum can be rapidly found where the yellow is such as will form a white light with it, or a yellow glass can be placed in the white light and a blue ray found, which, when mixed with it, forms white light. You see the mixtures before you, and I fancy will not find much fault with them. If we compare the blue-green spectrum ray which forms the white light with the light coming through the yellow glass, we find that it matches the blue of the glass very closely. Evidently then we can mix the light coming through these two together, and they should also form white light. This we can easily test. The blue glass is now in one beam of white light, and the yellow in the other. By superposing on the same screen these two lights, and then reducing them to proper proportions, we see that we have a white light which is a very close match to that of electric light.

Another step further we must go. Is the blue-green glass of that type which cuts off the proper amount of violet light? This we can answer at once by an appeal to the spectrum. We have the spectrum of the electric light on the screen, and place in front of the slit the glass. You will see that the violet almost entirely disappears, leaving the blue bright, but cutting off the red. We can do the same with the yellow glass, and we find that it cuts off all the violet and a deal of the blue-green. We have seen what sort of a white a mixture of the two make, and we can tell what kind of a spectrum they make by rapidly rotating in front of the slit a sector in which are the tw glasses showing proper proportions. We se now the spectrum of the combined lights upo the screen. It is quite different from that c white light, for there is no violet in it, an it has perhaps rather moıe green-blue in i but this is an advantage, as it shows tha the blues will not suffer when viewed in suc a light. In fact, a little more predominance if anything, will be given to the blues. Th figure below shows the luminosities of th naked spectrum, and that coming througl the yellow and blue glasses. Had I usec the ordinary cobalt blue glass you will se



that I should have gained nothing in safety. The spectrum, with such a glass interposed before the slit, is again on the screen. You will remember that it is a banded spectrum, admitting all the violet and blue, cutting off the green, but allowing a band of yellow and two of red to pass through. As the blue-green glass cuts off the violet, we may take it that it is much safer to use light coming through it, than ordinary white light, as far as the fading of pigments is concerned. It was in experimenting with this glass that I came to the conclusion that if we used the light passing through it as one component of a mixed light, and could find a light passing through a yellow glass which would neutralise it, we should have a valuable means of securing greater immunity from fading than we have by using white light alone. The yellow glass I have shown you was selected not as the most perfect sample, but as being very transparent. If anything, it wanted a trace more red with it, but without it we get a combination which ought to answer every purpose. Let me show you how some pigments look in this light. I place a lens in front of the lantern, and make a disc on the screen. Where the rays cross, a rotating

ector is placed containing these two glasses, ɔ that the disc is alternately illuminated y the blue-green and yellow light. The hange is so rapid, that the two colours blend ne into the other. I place various coloured ictures in the beam, and note their appearnce, and then illuminate them with ordinary hite light of the same intensity. We find ıat the two are almost exactly alike, every olour shows in the one as well as in the other, nd apparently a difficult problem is solved.

I well remember the first small experiment hich I tried with these glasses. It was in a mall photographic studio which we have at outh Kensington Museum, erected for the use f outside photographers. A small portion as curtained off and the roof glazed with hese glasses in proper proportions. Waterolour sketches were taken into this light, and ritically examined by some whose opinion I ighly value. The Chairman, for instance, hose exhibit at the New Gallery shows him o be a colourist of no mean order, approved, nd so did the Director for Art, Mr. Armstrong.

So successful was the appearance of the olours, that an experiment on larger dimenions was made by the authorities of the ıuseum when part of the roof of the gallery ı which the Jones collection is housed was lazed with these glasses. The public reely circulated through the gallery, and s far as I know the criticisms which vere passed were few, and certainly not s a rule condemnatory. The committee of rtists, who acted as advisers in art matters to Dr. Russell and myself, when carrying on the nvestigations as to the fading of pigments, nd of which Sir F. Leighton was the chairnan, gave it as their opinion that the lighting vas satisfactory.

When the Raffaelle Cartoon Gallery was to e re-roofed the authorities directed that the lazing should be carried out with these oloured glasses to prevent, as far as possible, ıny further fading of these valuable works of rt. The glazing is in alternate strips of the wo colours (some few panes have been glazed vith ordinary white glass to allow for slight nodifications in the proportions of the two olours, if considered desirable) on the slope f the roof. The light, before coming into the allery, traverses a flat skylight of corrugated vhite glass, which distributes and scatters he colour, even when sunlight streamed hrough the coloured panes. It has been ı source of amusement to myself to stop in his gallery and note the effect the light produced on the minds of the different parties who passed through it. The large majority of persons saw nothing peculiar about the light, and failed to notice the coloured glasses in the roof, whilst others noticed them and could not understand what they meant. Americans seemed to be those who were most observant. I have had the advantage of hearing the criticism of several artists regarding the lighting of this cartoon gallery, and the general dictum was that the colour and lighting were satisfactory. One artist told me he wished he could always have such a warm light in which to exhibit his pictures. He said it was a most becoming light. In choosing the proportions I was led to make a mixture which imitated as far as possible a mixture between a blue sky light and a warm sunlight. Light from a blue sky is always cold, and light reflected from clouds is, I believe, the illumination artists like. Hence my choice of these. When the light is principally from the blue sky, this meant that the yellow light predominated a little more than it would do when the mixture was made by the electric light. In order to arrive at this colour, I took sunlight itself as the standard white, and adjusted the proportions of sky light passing through the two glasses in such a manner that the warmth of a light from a sky partially covered with white clouds was found in the mixture.

It may be of interest to know what the illumination is compared with glazing by white glass, that is, how much is cut off. This can be very readily ascertained by measuring the luminosity of each colour coming through the glasses.

We can make the experiment for ourselves.

First I place the yellow glass in one white beam, and alongside it send another beam of white light. By intervening a rod in the paths of the two beams, to cast two shadows, and, reducing one by rotating sectors, which can give a larger or smaller aperture at will during rotation, we can arrive at a point where the two shadows are equally luminous.

Removing the glass, the balance is again secured, and we find that in this case the aperture required is 60°, and in the other 85°, showing that the yellow glass allows $\frac{12}{17}$ of the white light to pass through it. We can do the same with the blue-green glass, and find it cuts off a deal more, allowing only $\frac{1}{6}$ of the light to pass. Now, if half the roof be glazed with yellow glass, and the other half with the blue-green glass, the total light passing through is only 45 per cent. of what would

fall through the aperture of the roof if no glass were in it. Absorption and reflection by white glass reduces that loss to about 50 per cent., a great diminution, it is true, but still one which is made up for in several ways. In the Raffaelle Cartoon Gallery the open area in the new roof is considerably larger than it was in the old roof, and the light is practically the same as it was before. Further, the use of ground glass or blinds is done away with, ribbed glass being substituted. The ribbed glass, as before stated, helps the mixture of the two colours when falling on the pictures.

I do not say that the lighting is perfect and that improvements cannot be made in it. Science never comes to a finality, but I am bold enough to think that it is a step in advance. What may be termed the "fading value" of the light can be readily ascertained. In the diagram before you we have the photographic absorption spectra of the blue-green of the yellow glasses, and of the two mixed lights. It will be seen that the violet is totally, or very nearly, inactive. In the ultra-violet there is a carbon band which is intensely active, photographically, in the electric arc light. This is slightly transmitted through the yellow glass, but in sunlight these rays are so weak that they only appear after very prolonged exposure. What the effect is may well be judged by taking an ordinary photograph in this gallery and in the adjoining one. I find that a bromide plate requires nearly ten times the exposure in the former that it does in the latter, when photographing a picture. Bromide of silver, being sensitive to the green, does not show such a difference as chloride of silver does. Here are two pieces of such paper exposed for equal lengths of time, viz., one hour, in each of these galleries. You see that whilst the piece exposed in the ordinarily lighted room is quite dark, the photographic action appearing on the other is very small.

What the extension of time for fading is I cannot say. Putting it as low as ten times, we have a considerable saving. Thus, a picture which in ordinary light would last ten years will, if hung in this light, last at least 100 years, and probably 200 years. In some calculations made in our report, Dr. Russell and myself stated that it would take 100 years in one of the museum galleries for pigments to arrive at the fading shown by our experiments. Had this glazing been adopted, we should have to have increased this time to at least 1,000 years instead, a time sufficiently long to enable further advances to be made in the knowledge of what will completely hinder all fading.

I have now shown you the reasons whic[h] led me to experiment with this glazing, and t[o] judge it as efficient. I trust the lighting [o]f this Raffaelle Cartoon Gallery may prove not t[o] be merely a safe experiment, on a large scale but a real step in the right direction, which perhaps, may with advantage be adopted elsewhere.

DISCUSSION.

Mr. WALTER F. REID said he should like to p[ut] one or two questions to Captain Abney, which woul[d] no doubt open rather a wide field, and perhaps a fu[ll] answer to them would demand as much time as th[e] whole paper, which, of course, he could not expect but one question which he wished especially to ask, a[s] it seemed to bear essentially on the subject, was regar[d]ing the action of light on the various pigments themselves? They had seen some most beautiful display[s] of colour, and the manner in which Captain Abne[y] juggled with the various hues was somethin[g] marvellous. Artists would only be too glad if the[y] could obtain such pure colours on their palettes; bu[t] they could not dissociate colour from the materia[l] which produced it; and he should like to know i[f] definite experiments had been made on the chemica[l] action of light on the substances of which the pigments were made. With regard, also, to the mediu[m] with which the pigments were affixed to the substance, they knew that there were few substances i[n] which the media used did not act. Even cellulose o[r] paper had a certain chemical action on most pigment[s] which were applied to it; and they naturally looke[d] to one who was in the habit of using pigments t[o] know how far the action of light would be modified b[y] the chemical action of the medium to which they wer[e] united. The action of the invisible rays had bee[n] touched upon, but he did not quite catch what th[e] action of the ultra-violet rays might be, or whethe[r] they were totally excluded. It was known that the[y] acted, chemically, with very great vigour, but he di[d] not know whether that action was altogether excluded by the coloured glass. The practical aspect o[f] the question was of course very important; it woul[d] no doubt be possible to have artificial light of thi[s] kind in large public buildings, such as picture galleries, but he did not know how far it would b[e] applicable to ordinary houses. It was quite clea[r] that light of all kinds had a great influence, and perhaps the reason why such bright paintings wer[e] found in the Pyramids and in Pompeii was becaus[e] they had been completely protected from the chemica[l] action of light. If Captain Abney could point ou[t] any means of preserving paintings or the surface o[f] wood-work covered with different pigments, it woul[d] carry a ray of hope to many people.

Capt. Abney said the question of the chemical tion of light on pigments was a very long business, nd the matter was still *sub judice*. The experiments ere still going on, and as yet no report had been ade, so that he was afraid he could not enter upon atements which at present he was unprepared to ubstantiate. With regard to the action of the ultra-iolet rays that was a very small fraction of the adiation which affected pigments, and must almost e disregarded. He did not suppose the ultra-violet adiation in sky-light was $\frac{1}{50}$th part of that which acted, nd therefore if it were not dealt with at all, practically peaking no harm would be done; there might be ome very slight effect, but it would be of no im-ortance. But as a matter of fact these glasses cut off early all the ultra-violet. The violet bands in the arc ere very strong, and required a very great deal to cut hem off. He had said in the paper that his starting oint was when Dr. Russell and himself tried pig-nents under different coloured glasses, and though hat was quite true his researches dated back to a nuch earlier period. He used to be taken to church nd sat in the chancel, where there was a window glazed with zigzags of blue and yellow, and it was always a great puzzle to him that his prayer-book was beautifully illuminated with white light. He had given them the explanation that evening, but it was a great puzzle to him for many years, and it was not until the colour experiments were made that he was able to answer the question he put to him-self so many years before. If you could illum-inate a small church with windows of this kind you could illuminate houses, though he did not say they should do so, but that was one way in which they could do it, and still have all the benefits of white light, and without the irritating effects which the ultra-violet rays were supposed to exercise on the retina. The retina of the eye itself was fluorescent, and whenever there was fluorescence it seems pro-bable that nerve irritation may be set up. Houses might be glazed with quinine cells to get rid of the ultra-violet if thought desirable. He feared that was the only answer he could give to the questions which had been put.

The Chairman, in proposing a vote of thanks to Captain Abney for his interesting paper, said the total result of it seemed to be briefly this, that they could not eat their cake and have it. If you had pictures, and wanted to use them as pictures and look at them, you must expose them to vibrations; to some of those vibrations the pigments would respond, and to others they would not; but even the latter must produce some stress or strain, which eventually would affect the pigment; but those vibrations to which they responded had the effect of bringing the various molecules into unpleasantly close association with other bodies, from which they had better be kept apart; and the result was that certain changes were produced. Probably the most effectual agency in these changes was moisture, but even excluding moisture you were still sure to have changes go on, unless, indeed, you locked the colours up absolutely in glass, as in enamel or stained glass, or, as you found in Nature, in crystals, as in a sapphire, in which case they would in most, though possibly not in all cases, remain permanent. Otherwise it might almost be said that, in proportion as pigments were exposed, so would changes take place in them; and all you could expect to do was to mitigate the deleterious action of light by exposing the pigments only to such portions of the light as were necessary to enable you to see them, and to exclude those others which were not necessary and which might produce damage. They would all agree that Captain Abney had shown how, by a most ingenious and easily applied process, this could be affected, at all events in public galleries. He did not know whether people would care to have alternate panes of blue and yellow glass in their private rooms, but at all events in public galleries it was apparently a very effective method of preserving pictures, and one which could easily be applied. He must say that when Capt. Abney first proposed to glaze the skylights at South Kensington with this blue and yellow glass, he could not help fearing that in a few days there would be some frantic letters in the papers about it, but, fortunately, he did not think many people observed it, and it had now been going on for some time, and it was probably too late now for any-body to make a fuss about it. These results arose from the investigations which Captain Abney under-took with Dr. Russell at the request of the Com-mittee of Council on Education, and about the time they commenced their investigations there was a great deal of discussion in the public Press on the fading of water colours, and what was called the "gang" at South Kensington was especially held up to public opprobrium on account of their treatment of water colours. Why they were supposed to be worse than the rest of the world who exhibited pictures he did not know, but so it was. But he was glad to say that Captain Abney was still one of the "gang," and they had seen what he had done in the matter. It afforded an illustration of the old proverb that the best gamekeepeer was found in the reclaimed poacher. Certainly, as far as they knew at present, he had devised the most effective method, and one very readily applied, of preserving water colours and oil paintings, and giving them as long a life as possible.

The vote of thanks having been carried unani-mously,

Captain Abney, in responding, said he would warn those who painted in oil against thinking they were much safer than those who used water colours.

Miscellaneous.

REVIVAL OF THE RAMIE INDUSTRY.

The following particulars as to what has been done lately for the advancement of this industry are taken from the *Board of Trade Journal*, which quotes from the *South American Journal*:—

The cultivation and treatment of the ramie plant as an industrial product is once more arresting attention as a field for the profitable employment of capital. At one time it was feared that the possibilities of the new textile had so far fallen short of expectations as to wreck its chances of ever again being taken up on a sufficiently large scale to allow of its attaining any measure of success. Enterprising capitalists, who had placed unbounded faith in the future of ramie, found that the new industry was insatiable in its demands for money, swallowing up some hundreds of thousands of pounds, for which, in return, the unhappy capitalists found themselves the possessors of a few bales of fibre. For three or four years past the ramie has been closely studied in all its phases, in its chemical constituents and practical and scientific treatment, with the result that the processes of decorticating and de-gumming the stalks have at last been established upon a scientific basis. As the ramie gives an exceedingly small quantity of raw fibre—about 3½ or 3 kilos. for every 100 kilos of green stalks—the only way of making it a commercial success was to treat it in enormous quantities at the lowest possible limit of cost. This, of course, necessitated the designing of machines upon the simplest lines. Many of the machines have, during the past year or two, been greatly improved, their mechanism has been simplified by converting them from retrograde into direct-acting, and new appliances have been introduced that seem to have reached the limit of simplicity of design. It may be said that the ramie problem has now been definitely solved. The swallowing up of a vast amount of capital in the industry has not been without its beneficial results. It has afforded experience from which inventors are now profiting, to place the industry upon a really practical basis, and the treatment of ramie can now be carried out upon lines that will enable it to take its place among the other textiles, that is to say, above cotton, and flax, hemp, and inferior only to silk in point of "number" or fineness.

One of the largest textile firms in Lille, who some time ago laid down a ramie-spinning plant, lately received an order from the United States for a quantity of velvet, made from the ramie fibre. Singularly enough, the firm was not in a position to execute the order at once, owing to there not being enough fibre in stock, and some time has been lost in applying to inventors, who have processes at work, for a consignment of the material; in fact, if any large demand for ramie textiles were experienced at the present day, it is certain that manufactu would not be in a position to meet it, and a gr deal will have to be done before sufficient fibre placed upon the market to allow of the establishm of a large textile industry. Yet there is no dou that if a steady consumption of fibre were experienc there would soon be an abundance of raw mate ready for the manufacture.

Another encouraging fact lies in a new enterpr that appears to be on the point of being carried in England. Some English capitalists, it is report have lately visited several well-known ramists Paris, with a view of ascertaining their opinions up samples of de-gummed *lanières* that had been treat —presumably by a new process—at a cost of centimes the kilo. The samples are said to be excellent quality, and superior to anything yet plac upon the market. These capitalists are, we hear, the point of laying down machinery in England the manufacture of 80,000 kilos of spun ramie month, an undertaking of such stupendous magn tude that French ramists are doubtful whether it c be carried out in the present stage of ramie develo ment. The present supply of *lanières* is conside ably short of what would be required for such heavy production of textile; and it would be necessa to lay out new plantations for the supply of t manufactory. This would seem to offer an excelle opening for the cultivation of ramie in Mexico, Par guay, or in other of the South American States, the prolific yield in those countries, and the faciliti for transport to England, would place an adundan of cheap *lanières* at the disposal of English man facturers.

With reference to the subject of the preparation ramie fibre, a communication has been received the Board of Trade from the Foreign-office, enclosin a copy of the United States Senate Miscellaneou Document No. 20, in which appears a statemen which has recently been presented to the Senate the United States calling attention to the efforts Mr. S. H. Slaught, of California, to further th industry. Mr. Slaught claims that he has discovere a process for working up ramie. A Bill for th development and encouragement of silk and rami culture in the United States, under the supervisio of the Secretary of Agriculture, was proposed b Mr. Slaught; it passed the Senate on the 14t June, 1894, and was submitted to the committee whole house on the 9th August last.

By this Act the Secretary of Agriculture i "directed to establish five silk experiment station and three ramie stations—one each, respectively—i different sections of the country, with a view o developing silk and ramie culture throughout th United States. Said silk stations shall be a part o the several experiment stations in the States in whic they may be located. The ramie stations shall b one in or near Washington, district of Columbia one in the South Gulf States, and one on the Pacifi coast, where the special agent can procure the most

stance and co-operation from the people and italists in locating or starting them. The work each station for silk shall be conducted under ervision of the director of such station, and the ie demonstrations by an appointee of the Secretary Agriculture, and they shall carry on said work er rules and regulations to be prescribed by the retary of Agriculture. A sum of 5,000 dols. for h station annually (and 50,000 dols. additional the year, for each of the ramie stations) is hereby ropriated, out of any money in the Treasury not erwise appropriated, to each of the stations for and ramie culture, which shall be established ler the provisions of this Act."

CEIPTS OF PARIS THEATRES IN 1894.

The French authorities have recently issued a tement showing the gross receipts of the principal atres and places of amusement in Paris during the r 1894, to which is added a return showing the ounts realised by public balls and *cafés concerts*. e general total amounts to the sum of £1,170,300, increase of £45,000 over the amount realised in 93, and £242,000 more than in 1892. It should, wever, be observed in reference to the comparison ween the years 1894 and 1892, that 1893 was the t year in which the Administration of Public sistance included under the heading of theatres, perly so-called, *cafés concerts* and other similar ablishments which did not appear in previous rs. It is somewhat curious to find that in spite of itical circumstances and economical and financial ses, the receipts at the Paris theatres show a stant and steady increase for many years past. e progress has not been entirely uninterrupted; example, in 1870 and 1871, for reasons which will well understood, the takings of all places of ertainment dwindled to a considerable extent. ring the last two years of the Empire, 1868 and 59, the receipts were respectively £492,000 and 04,000. In 1891 and 1892 they were respectively 44,000 and £900,000—an increase of from 80 to per cent. In the Exhibition years of 1867, 1878, d 1889, the receipts were respectively £876,000, ,226,000 and £1,285,000. Taking the amounts eived from each establishment, we find that the era as usual heads the list, with a revenue of 25,000. Then comes the Comédie Française with 0,000 and the Opera Comique with £61,000. It is ittle curious to find the receipts are frequently in erse *ratio* to the seating capacity of the theatres emselves. For example, at the little theatre of the naissance a sum of £52,000 and at the Vaudeville 9,000 was realised, while the immense theatre of e Chatelet only yielded £36,000, and the Odéon 7,000. The Nouveau Cirque realised £30,000 in eipts while the Cirque d'Hiver only yielded 3,000. On the list of *cafés concerts*, the Folies rgères heads the list with receipts amounting to £45,000, and La Scala comes next with £24,000. Then follow Olympia with £19,000, the Ambassadeurs with £16,000, Eden Theatre £15,000, and the Ba-Ta-Clan with £13,000.

THE CEREAL CROPS OF JAPAN.

An estimate has been made of the area yield and total production of the principal cereal crops of Japan in the ninth Annual Report of the Japanese Department of Agriculture and Commerce, which has just been issued. The most important cereal crops of the country, next to rice, are barley and wheat. Barley is cultivated in almost all provinces, and, either as flour or whole grain, boiled with various quantities of rice, is used as very common food, both by farmers and other classes of people in Japan. For this purpose, it is whitened like pearl barley, steeped for five or six hours in water, and then boiled. One of the most common articles of food in Japan is *miso*, which is prepared by pounding together boiled soy beans, salt, and the *koji*, or yeast, prepared from common barley. Barley is also used for brewing beer, making confectionery, and for food for horses and cattle. Its straw, bleached and plaited, is much used for manufacturing summer hats, and other articles. Wheat is cultivated in nearly all the provinces. It is principally used for preparing soy, vermicelli, and various kinds of confectionery. For preparing *oumen* (a kind of vermicelli), wheat flour is made into dough with salt water, and then drawn out into fine threads, which are cut into certain lengths. The only difference between *oumen* and common vermicelli is, that no oil is used in the preparation of the former. For preparing *undon*, a kind of maccaroni, ten parts of wheat flour and three parts of potato starch are kneaded by hand, with a certain quantity of brine, then rolled out into thin sheets, folded into layers, which are cut into fine threads, and dried by the sun. Wheat straw is used for thatching roofs, and for similar purposes. A small quantity of both barley and wheat is annually exported to foreign countries, the former chiefly to Hong Kong and Vladivostock, and the latter, in the form of flour, to Russia, Korea, &c, and in the form of grain to Hong Kong, England, &c. The manufacture of straw plaits and other straw goods from bleached barley stalks is assuming large proportions in Japan. Some farmers bleach the straw of the barley which they have grown in the intervals between field work, and sell it to the plait manufacturers; but the farmers generally—after harvesting and threshing the barley—cut the upper part of the straw to the length of about one foot, and sell it to the straw plaiters. Although Japanese straw is not so good as that of Italy, it is better in quality than that of China and other countries. In Japan, articles of straw, especially toys, have been made for many centuries, but recently, on account of the increasing exportation

of straw plaits to foreign countries, and especially to the United States, the manufacture of plaits has increased year by year. The area under barley in 1893 was estimated at 3,232,000 acres, and the product 68,700,000 bushels; wheat, 1,042,000 acres, and 16,477,000 bushels; total cereals, exclusive of rice, 4,274,000 acres, and 85,177,000 bushels.

FRENCH WATERWAYS.

According to the latest return on the subject, the canal system in France comprises 12,396 kilometres or 7,747 miles of rivers and canals open to inland navigation. The first attempts at canalisation were made under the Roman domination, Marius in particular having achieved an additional claim to fame from having dug with his legions a canal from Arles to the sea, but during the invasions of the barbarians which followed, the canals orginated by the Romans fell into desuetude and disuse. It was in the beginning of the 16th century that a new era was marked in canal navigation in France owing to the invention of locks. It had previously been the custom to construct inclined planes at any point where there was a fall in the water, and the boats were dragged over these inclined planes with ropes. The 17th and 18th centuries showed a considerable expansion of the canal system, and at the moment of the fall of the Monarchy in 1789 there were 1,770 kilometres (1,106 miles) of canals in France, of which 1,000 kilometres or 625 miles were open to navigation. During the period of the Revolution and the first Empire, 1789-1814, but little attention was paid to the extension or improvement of the system of inland navigation, only 200 kilometres (125 miles) being opened to traffic. Her Majesty's Secretary of Embassy at Paris says that under the reign of Louis Philippe, 1830-47, 2,000 kilometres (1,250 miles were opened to circulation, and important works were undertaken for the improvement of several rivers. The early part of the Second Empire was not a prosperous one for the development of the canal system, the spirit of the day being turned to railways, but a change of public opinion took place in 1860, and the further development of the system was anxiously demanded by commercial classes as a natural counterbalance to the railway monopolies, and a sum of £2,460,000 was thus expended during the Second Empire. From the year 1814 to the end of 1891 the expenditure made by the State upon the French canal system amounted to the enormous total of £56,424,887. As regards the administration of the 12,396 kilometres (7,747 miles) of canals and inland waters open to navigation, of which 3,003 miles were canals in the simple sense of the word, the remaining 4,744 miles being navigable rivers, streams, lakes, and ponds, nearly the whole of the system of inland navigation is administered by the State, only a very small portion being conceded. Thus, out of 7,747 miles, only 536 miles have been handed over to concessionaires, against 7,211 m which are managed by the State. On August 1879, a law was passed by which the waterw forming the chief lines of communication shoulc divided into two classes, viz., principal lines lines of secondary importance. According to text of that law, it is necessary that on the princ lines there should be at least a depth of 6½ fee water, and the locks should be at least 126 feet l by 17 feet broad. The main object of this law to ensure the possibility of the free circulation on canals of the Flemish barge of 300 tons, 125 long by 16⅓ feet broad, and 5 feet 10 in draught. In 1878, previous to the en ment of this law there were but 912 miles navigable waterways answering to these conditi while in 1892 there were no less than 2,562 mile this class, showing the very marked increase of 1, miles in fourteen years. Navigation on canals previously been confined to merely local transp on account of the great diversity of local conditi in different parts of the country. Since the adopt of this law and the consequent improvement of canals and locks, a barge of 300 tons can n navigate direct from Havre to the frontier of Als a distance of 514 miles, or from Dunkirk to Lyo 687 miles. There are still, however, many impro ments to be yet oompleted on the canals in Bo bonnais and Burgundy. The canal from the Ma to the Saône, and that from the Saône to Doubs, remain unfinished for want of funds. T extension of navigation to the Rhone awaits construction of a canal to Marseilles, which can o infuse into this line any commercial prosper Owing to the improvements made since 1879 great impetus has been given to the carrying tr by inland waters. Thus, in the year 1881, weight of goods carried on canals alone represen nearly 19 per cent. of the total amount of goo carried by rail (19,700,000 tons out of a total 104,000,000 tons), yet in 1891 the total wei of merchandise transported by inland navigati amounted to a proportion of 22 per cent. Moreov during this period of ten years, although the leng of railway lines increased 58 per cent. (from 14,0 miles in 1881 to 21,875 miles in 1891), the weig of merchandise carried by rail and the kilomet tonnage have only increased 17 per cent. and per cent. respectively, while on the canals wh the lines in use have only increased a fracti more than 3 per cent. (from 7,480 miles in 1881 7,704 miles in 1891) the total weight of m chandise embarked, increased during the sa interval by 27 per cent., and the kilometric tonna by 67 per cent. By a comparison of the statistics past years, it is proved that the goods transported inland navigation consist chiefly of heavy and cumb some kinds of merchandise, and that the propo tional tonnage of each class of goods varies b little from year to year. Building materials abso about 32 per cent., or one-third of the total tonnag

nineral combustibles 28 per cent. Agricultural ood products are represented by 14·5 per cent., l by 8 per cent., minerals by 7·5 per cent., and ures, &c., by 5·5 per cent. There is a consider- international canal traffic on the north-eastern ier of France, the canals linking the Escaut, Sambre, and the Meuse being connected with Belgian system of inland waterways, while on other hand the canals connecting the Moselle and Maine to the Rhine, and the Rhone to the ie, serve as a means of communication with nany by inland water. The greater part of this national traffic is with Belgium, of which two- ls are the importation of coals from the coal icts of Mons and Charleroi. In order to acquire orough knowledge of the number and size of s available for navigation on rivers and canals, Ministry of Public Works in the years 1887 and carried out a census of all the ordinary boats, es, or steam-boats, used for the transport of chandise and navigating the French system of d waters, with the exception of those of less than ns register. Thus it was found that on May 16th, , there were 15,925 boats capable of transporting 6,230 tons. Of these 4,191 were of more than 300 , 3,297 of 300 to 200 tons, 2,459 of 200 to 100 , 2,892 of 100 to 50 tons, and 3,085 of 50 tons tons.

AGRICULTURE IN THE YANG-TSE BASIN.

he general character of the country in China n Shanghai to Hankow, and for a hundred miles each side of the river, is that of rich alluvial ns, traversed by ranges of hills having usually east and west trend. The tops of the hills give best tea, and where the ground is too stony for cultivation, fir and oil trees are planted in regular s, which yield oil, resin, timber, and firewood. the lands of intermediate height, or where the is too porous to hold the water during the wth of a rice crop, cotton, wheat, maize, buck- eat, sweet potatoes, and culinary vegetables are de to grow in great profusion. It appears from recent report in the *Agricultural Gazette* of New ith Wales, of a mining engineer lately in the vice of the Chinese Government, that dairy farm- is quite unknown in these provinces, and milk is ked upon with disgust by the majority of the abitants. The water buffalo is the most useful mal for the cultivation of rice, as his immense ength enables him to do a long day's work knee- ep in mud, and he can feed well along the swampy rders of lakes where ordinary cattle would be lost the bogs. Three crops can generally be secured m the land in a year, though in some severe sons the winter crop may become damaged by ow and frost for a week or two in January. In ne districts indigo and opium are much grown, the exclusion of other crops, but it is not the general rule. Most of the Chinese housewives like a few indigo plants near at hand, sufficient to make a vat of dye for the clothes of the family. Any other colour is rarely seen in these provinces. The plants are macerated in wooden tubs, and the resulting indigo is reduced in order to render it soluble. The bamboo is an article of considerable value to the Chinaman. Little labour is required to cultivate it, as once planted it continues to produce for generations, and the occasional stocking up of an old root is all that is required to keep the bed in order. In many respects the bamboo takes the place of metals, and although the Chinese have been acquainted with iron, copper, and brass from very early times, yet the bamboo has played an important part in preventing these metals from being so generally used as among Western nations. For coopering tubs, and other wooden vessels for joinery, the Chinaman can use bamboo. The young shoots make an excellent vegetable, and paper and twine of great strength are produced from its fibre. Although the agricultural implements used appear, at first sight, to be of rude construction, yet they are fairly well adapted to the needs, and the final results leave little to be desired. The fields are all cultivated like gardens, and the crops, when growing, are kept well hoed and clear of weeds. All the tools with cutting edges, such as hoes, picks, sickles, pruning hooks, &c., although of purely native manufacture, are all steeled and tempered on the edge. As regards the system of cultivation, in the case of two of the most important crops, namely, cotton and rice, the following are the details:—In cotton cultivation the seed is first mixed with dry earth, to prevent their sticking together; slight cavities are then made in the ground, about two feet apart, between the rows of wheat, and three or four seeds thrown in each, and lightly covered, and then a small teacupfull of an emulsion of manure in water is poured over. After the wheat is cut, and the cotton about four inches high, it is hoed and thinned out, so as to leave one or two plants at each setting, and then another dose of emulsion is applied round the roots. No more care is now needed until the cotton is ready for gathering; and it is just at this time—from June to August—when everything is growing under tropical heat and moisture, that the farmer is at leisure to collect and make stores of manure for the next crop. Rice is more complicated, but may be roughly described as follows:—The seed, rolled up in straw bundles of about 50 lbs. each, is steeped for 24 hours in water, and then thickly sown on a patch of highly-manured ground, and the other fields ploughed up and water run to the depth of two inches. When the rice has grown in the bed to the height of six inches, the fields are harrowed till they are worked into a thin mud, which settles in a few hours perfectly level. The rice plants are then removed in handfulls from their birthplace and transplanted out singly, about eighteen inches apart, in the fields that have been prepared for them. This operation of transplanting is usually accom-

panied by much beating of gongs and firing of crackers. In about a month the crop is eighteen inches high, and it then begins to turn a sickly yellow colour; slacked lime is then sprinkled on, and in a couple of days it is turned dark green, and flourishes rapidly. The supply of water must be kept up until the grain is thoroughly ripe; it is then run off, and two days after it is reaped with a sickle. At the time of rice harvest, the dry season has already set in, and the Yang-tse is rapidly falling, but the running of the water off the paddy fields is so simultaneous over the country that the river always rises, it is said, two or three feet for a week and then goes down again.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock:—

May 22.—"The Dressing and Metallurgical Treatment of Nickel Ores." By A. G. Charleton, A.R.S.M.

Indian Section.

Thursday Afternoon, at Half-past Four o'clock:—

May 23.—"The Northern Balochis; their Customs and Folklore." By Oswald V. Yates, A.M.Inst. Civil Engineers, late Executive Engineer, Indian Public Works Department.

[Sir James Lyall's paper on "Punjab Irrigation," previously announced for this date, is unavoidably delayed until next Session.]

Foreign and Colonial Section.

Tuesday evening, at Eight o'clock:—

May 21.—"Commercial Education in Belgium." By Professor William Layton. Lord Reay, G.C.S.I., G.C.I.E., will preside.

Applied Art Section.

Tuesday evening, at Eight o'clock:—

May 28.—"The Decoration of St. Paul's." By Prof. W. B. Richmond, A.R.A. The Very Rev. the Dean of St. Paul's will preside.

Cantor Lectures.

Monday Evenings, at Eight o'clock:—

Ernest Hart, D.C.L., "Japanese Art Industries." Two Lectures.

Lecture I.—May 20.—The Industrial Arts of Japan during the pre-commercial era—The treaties of commerce and the commencement of the industrial period—The opening of treaty ports—Statistics and progress—Present status of silk-weaving, embroidering, cotton-printing, crêpe-printing—Fan-making and fans.

Lecture II.—May 27.—Japanese bronzes, ancient and modern—Ornamental metal work—Shakudo, shibuitchi, antimony—Cloisonné and other enamels—Wood engravings and hand block-colour-printing—Photographing.

MEETINGS FOR THE ENSUING WE

Monday, May 20...SOCIETY OF ARTS, John-s Adelphi, W.C., 8 p.m. (Cantor Lectures.) Ernest Hart, "Japanese Art Industr (Lecture I.)

East India Association, Westminster Town-h p.m. Mr. Thomas H. Thornton, "Sir R Sandeman and the Indian Frontier Policy."

British Architects, 9, Conduit-street, W., 8 Mr. G. Baldwin-Brown, "Anglo-Saxon A tecture."

Medical, 11, Chandos-street, W., 8½ p.m. Ar Oration.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ Lecture by Prof. E. Hull.

Tuesday, May 21 ... SOCIETY OF ARTS, John-st Adelphi, W.C., 8 p.m. (Foreign and Col Section.) Prof. William Layton, "Comme Education in Belgium."

Royal Institution, Albemarle-street, W., 3 Prof. E. Ray Lankester, "Thirty Years' Pro in Biological Science." (Lecture II.)

Statistical, United Service Institution, White S.W., 5 p.m. Mr. E. Orford Smith, "Munic Finance, or Local Taxation and Local Expe ture, as illustrated by the case of the Cit Birmingham."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 50, Great Russell-street, W.C., 8 Mr. William Gamble, "Apparatus for Pro Photography."

Zoological, 3, Hanover-square, W., 8½ p.m.

Wednesday, May 22...SOCIETY OF ARTS, John-str Adelphi, W.C., 8 p.m. Mr. A. G. Charleton, " Dressing and Metallurgical Treatment of Ni Ores."

Geological, Burlington-house, W., 8 p.m.

United Service Institution, Whitehall-place, S.W p.m. "Kites: their uses in War."

Royal Society of Literature, 20, Hanover-squ W., 8 p.m.

Inventors' Institute, 27, Chancery-lane, W.C., 8 p

Thursday, May 23 ... SOCIETY OF ARTS, John-str Adelphi, W.C., 4½ p.m. (Indian Section.) Oswald V. Yates, "The Northern Balochis: t Customs and Folklore."

Society for the Encouragement of Fine Arts, 9, C duit-street, W., 8 p.m. Conversazione at Galleries of the Royal Institute of Painters Water Colours, Piccadilly, W.

Royal Institution, Albemarle-street, W., 3 p. Dr. W. Huggins, "The Instruments and Meth of Spectroscopic Astronomy." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W 8 p.m. Discussion on Mr. M. H. Robinso paper, "The Recent Development of the Sin Acting High-Speed Engine for Central Statio Work."

Friday, May 24...Royal Institution, Albemarle-street, W 8 p.m., Weekly Meeting, 9 p.m. Mr. J. V. Jon "The Absolute Measurement of Electrical Resi ance."

Clinical, 20, Hanover-square, W., 8½ p.m. Annu Meeting."

Physical Science Schools, South Kensington, S.W 5 p.m. 1. Dr. Kuenen, "Mixtures of Ethane a Nitrous Oxide." 2. Mr. Burstall, "The Measur ment of Cyclically Varying Temperature."

Saturday, May 25 ... Botanic, Inner Circle, Regent's-par N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. M Seymour Lucas, "Picture Making." (Lecture II

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FRIDAY, MAY 24, 1895.

l communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take ace at the South Kensington Museum (by ermission of the Lords of the Committee of ouncil on Education), on Wednesday, June)th.

The reception will be held by Major-General r John Donnelly, K.C.B., Chairman, and e Members of the Council of the Society, om 9 to 10 p.m.

Each member is entitled to a card for himelf, which will not be transferable, and a ard for a lady. These will be issued shortly. 1 addition each member will be able to purhase two transferable tickets, the price of hich will be 5s. each up to the day of the *onversazione*; on that day the price will be aised to 7s. 6d. It is requested that members equiring these additional tickets will make arly application for them. Every application ust be accompanied by a remittance.

Promenade Concerts will be given in the Iorth Court and in the Textiles Court of the Iuseum, commencing at 9.15 p.m.

A Glee and Madrigal Concert will be given t intervals in the Lecture Theatre, comnencing at 9.30 p.m.

A Vocal and Instrument Concert will be iven in one of the galleries of the Museum, ommencing at 9.30 p.m.

Light refreshments (tea, coffee, ices, claret up, &c.) will be supplied at the usual Reeshment Buffets in the Central Corridor of ne Museum.

As the old Museum quadrangle is now overed in, none of the entertainments will e in the open air.

Further particulars as to the musical and ther arrangements will be given in the proramme, which will be distributed on the vening.

CANTOR LECTURES.

On Monday evening, 20th inst., Mr. Ernest Hart delivered the first lecture of his course on "Japanese Art Industries."

The lectures will be published in the *Journal* during the summer recess.

FOREIGN AND COLONIAL SECTION.

Tuesday, May 21; Sir Owen Roberts, M.A., D.C.L., in the chair. The paper read was—"Commercial Education in Belgium." By Professor William Layton.

The paper and report of the discussion will be published in a futnre number of the *Journal.*

Proceedings of the Society.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 22, 1895; Francis Cobb, Treasurer of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Boot, Horace L. P., 51, Stockwell-park-road, S.W.
Caithness, J. E., 150, Leadenhall-street, E.C.
Moncrieff, Colonel Sir Colin Campbell Scott, K.C.M.G., C.S.I,, 11, Cheyne-walk, Chelsea, S.W.
Taylor, Henry, Queen's-road, Clevedon.
Thompson, George Rudd, 57, Dock-street, Newport, Mon.
Vellacott, Captain John William, Bideford, Bond-street, Albert-park, Melbourne.

The following candidates were balloted for and duly elected members of the Society.

Adams, Walter, 64, Watling-street, E.C.
Fremantle, Hon. Sir Charles W., K.C.B., 10, Sloane-gardens, S.W.
Lethbridge, Sir Roper, K.C.I.E., Lynsted-lodge, Lynsted, Sittingbourne.
Rawlings, John Joseph, 18, Earl's-court-gardens, South Kensington, S.W.

The paper read was—

THE DRESSING AND METALLURGICAL TREATMENT OF NICKEL ORES.

By A. G. Charleton, A.R.S.M.

I had the honour last Session of reading a paper before this Society upon "The History, Uses, and Distribution of Nickel," and, at the

kind invitation of the Council, I hope to pursue the subject a step further to-night, and deal with the methods which are applied commercially to the extraction of true metal from its ores.

These methods group themselves naturally into two main divisions, dressing and smelting; the ore in some, but not in all, cases requiring to be dressed, in order to concentrate lean or low grade material, to bring it up to a sufficiently high grade for the smelter; in other cases, to separate minerals of different specific gravity and different composition, which it is inadvisable, if not impossible, to submit to a similar subsequent course of treatment. The broad line of division which nature has drawn, mineralogically, which divides ores of nickel into two main classes—(1) silicate and (2) sulphide or pyritic ores—necessitates an entirely different scheme of treatment in the two cases.

Dressing.—New Caledonia.

The treatment of garnierite (hydrated silicate of nickel and magnesium) in New Caledonia is exceedingly simple. The mineral at the quarries is picked over by hand, and is divided into two classes—ore above 8 per cent. tenor of nickel, and ore below that limit. The dressing operations which follow are carried on below the mines, as water cannot be obtained at the hill-side workings. The object of this washing treatment is simply to cleanse the mineral from the red clay with which it is associated, and even this involves the risk of considerable loss, if carried too far, amounting sometimes to 3 or 4 per cent. in the mud washed away. The "waste" from the quarries carries about the same amount of nickel, and tailings of this tenor cannot be profiably rehandled.

The washing operations are, I understand, conducted on "tyes" of a very simple construction, and, as the loss would appear to be entirely a mechanical one (owing to the absence of any attempt at classification), I should be inclined to think that a considerable saving of mineral might be effected by washing the ore in riddles of the type illustrated by Dr. Le Neve Foster ("Ore and Stone Mining," p. 541), set in series or by passing it through larger drums provided with several fields of sieves, which would graduate it in size. This simple machinery might be driven by water power.

White men are employed for the management and supervision of mining operations, at rates running from 12s. to 16s. per diem, whilst the men under them consist of assi[gned] convicts, who are obtained on contract [from] the Government — ticket-of-leave-men, [who] are paid at the rate of 4s. 2d. to 5s. [per] diem; Kanakas, imported from the [New] Hebrides, who get their board and 16s. [a] month; Chinese and natives of Tonquin [(im]ported under agreement), who are paid a[t the] rate of 2s. 9d. per day. The Kanakas a[re of] service for transport and lighterage, but ca[nnot] stand the mountain air up at the mines, w[hilst] the natives of New Caledonia seem to o[bject] to work at home, and prefer to change pl[aces] with the Kanakas and seek work in [the] coffee plantations of the New Hebri[des]. The Chinese are good workmen, but o[wing] to political and diplomatic complication[s, a] supply from China proper has of late y[ears] been unobtainable. The Tonkinese are [said] to be the most satisfaclory class of labour, [and] are said to do more work at the price they [are] paid than the convicts.

The delivery of the ore from the quarrie[s is] effected (as stated in my former paper) [by] means of single wire-rope tramways, in [bags] holding 100 to 120 lbs., by which means s[mall] quantities up to 7 or 8 tons can be deliv[ered] daily.

These cable tramways are of an exceedi[ngly] primitive description. Though attaining sp[ans] varying from 500 to 600, and occasionally [800] metres, they require a minimum slope of [8°] for the hardwood carriers to slide down t[hem] properly, and these latter only last fifteen [to] twenty trips.

The carriage from the lower stations to [the] shore is effected by cart or rail, but as [the] mines actually at work are all situated onl[y a] few miles from the coast, these distances [are] never very considerable.

The expense of transport from the min[e to] the port of shipment is said to vary from [...] to 8s. 4d. per ton, according to the situat[ion] of the mine, which must be added to the c[ost] of mining the ore; this usually amounts [to] from 12s. 8d. to £1 13s. 4d. per ton (1,[000] kilos).

The embarkation is done in lighters, car[ry]ing 12 to 15 tons each, and the cargoes [are] sent direct to Europe, or by transshipmen[t at] Noumea and Sydney. During the Austral[ian] wool shipping season steamers and sail[ing] vessels carry ore and regulus at nomi[nal] freights as ballast. Direct shipment in la[rge] sailing vessels is less feasible, owing to [the] dangerous reefs round the coast, and [the] harbour of Noumea, being the only [...]

ed, the other ports are unapproachable, pt by daylight, with a fair wind.

·e containing 7·5 to 8·5 per cent. nickel is h at the port of shipment £4 7s. 6d. per (frs. 105), and ore with 9·51 to 10·50 per . nickel (frs. 125) £5 4s. 2d. per ton. The ɜs quoted which miners working singly or mall parties on a sort of tribute system in for their ores varies, of course, with the ket value of nickel in accordance with the r of the ore, rising rapidly as the per- age increases. Advances in provisions goods, or what would be called in ɜrica "grub-stakes," are made to the ɜrs who work the ore on tribute singly ı small parties, and sometimes even cash ınces can be got against the ore, subject eimbursement on its delivery, so that any ve miner can generally find work on his account in New Caledonia, even without ital.

he freight from Noumea to Havre is (frs. 40) 13s. 4d. per ton of ore, about 1s. 6d. per with 5 per cent. ore, but it used to be 50) £2 1s. 8d., until the French Company Nickel built its own ships.

Canada.

eckoned upon 61,924 tons of ore smelted, average contents of all the ore produced by Sudbury mines, in 1891, was 3·36 per cent. ickel, but the ore of three of the companies king in this district carried 3·19 per cent. opper in addition, and the ore of one mine led, on an average, ·1007 per cent. of alt. The Canadian ores, like those of way, are merely sorted over by hand, and not subjected to any mechanical con- ration.

	Copper Cliff.	Evans.	Stobie.
a	13·44	24·55	12·50
....	39·02	35·18	47·25
hur	26·26	18·27	25·26
per	4·31	1·43	1·92
el	5·57	3·74	2·36
nina	4·49	8·02	3·30
e	2·28	2·06	1·48
nesia	·95	1·67	·80
sphorus	·015	·01	·018
ganese	·09	·08	·09
sture	·15	·07	·09
	96·575	95·08	95·068

The ore from the fines is hoisted to rock-houses, where it is roughly sorted, the rock being wheeled to a dump, and the distinctively nickel ore or copper ore being piled on either side. A Blake crusher breaks the ore, and allows it to fall through revolving screens, the coarse ore passing a 4-inch, the medium or raggings a $1\frac{3}{4}$-inch, and the fine ore a $\frac{3}{4}$-inch opening. The raggings and the fine ore pass direct to their respective bins, while the coarse ore falls from the screens on washing-tables. It is here passed under a spray of water, and while carried forward by the tables is rapidly sorted by boys, who pick out any pieces in which nickel or copper seems to predominate, throwing these into separate bins, while the average mixed ore falls from the end of the tables into a hopper. The analysis in the preceding Table of an average month's output from three typical mines shows the character of the ore.

As the iron is in part combined as silicate, part as pyrrhotite, and part as chalcopyrite, the balance unaccounted for represents oxygen. A month's output from the Evans Mine shows the results obtained by sorting the ore:—

Evans Mine, regular run, mixed ore—

	Copper.	Nickel.
Coarse	1·62	3·45
Raggings ..	2·99	3·90
Fines	3·78	5·04
,, ,, *picked nickel ore—*		
Coarse	·58	5·13
Raggings ..	1·14	4·87
Fines	1·36	6·64
,, ,, *picked copper ore—*		
Coarse	11·74	1·80
Raggings ..	11·15	2·46
Fines	13·45	3·35

On July 20th, 1892, Mr. T. A. Edison filed an application in the United States Patent-office, which resulted in his being granted Patent No. 488,842, on November 8th, 1892, for the magnetic treatment of nickeliferous pyrites, in which he describes his method thus:—

"In carrying out my invention I proceed as follows:—Assuming the ore to contain nickeliferous pyrrhotite or magnetic pyrites, calchopyrite or copper pyrites, with gold, &c., I first grind the whole of the crude ore so as to eliminate the pyrrhotite, gold, &c., from the worthless gangue. The crushed ore is then

concentrated by jigging, or vanning, or by any other appropriate concentrating method, thus giving a concentrate containing the nickeliferous pyrrhotite gold blend and galena, without any material quantity of quartz or other worthless matter. This concentrate is then passed through a magnetic separator, which is capable of working wet ore, or the concentrate is dried and passed through a magnetic separator adapted to work dry ores. The magnetism is so regulated that only the particles of magnetic pyrites which contain no nickel or cobalt are acted upon, the magnetism being too weak to draw away the less magnetic or nickeliferous pyrrhotite. After the pure pyrrhotite has thus been separated the remainder of the concentrate is run through a more powerful magnetic separator, which withdraws the nickeliferous pyrrhotite, leaving all the other or non-magnetic materials.

"The nickeliferous pyrrhotite which is obtained in this way, although small in quantity, compared with the whole amount of ore, will be sufficiently rich to be put into a matte by the regular methods. The remainder of the concentrate is then washed in a closed cylinder, with slight access of air if desirable, to render the copper pyrites magnetic, when the magnetic copper pyrites may be withdrawn from the rest of the material by a magnetic separator, as may be explained in my patent, No. 465,250. After the copper pyrites have been withdrawn from the concentrate the remainder, containing the gold, silver, zinc, lead, &c., of the original ore, is worked in the wet way, or matted, and worked electrolytically, as will be well understood." Mr. McTighe is said to have devised an improvement on this process, but I am not at present in possession of particulars with regard to it. The selective action of magnetism on pyritic ores of nickel certainly appears to offer a field for further investigation, and may be capable of important commercial application.

The principal mining districts at present are Thio Nakéty, Canala, and Kouaoua, on the east coast, and Dumbea, Bourail, Paouéa, and Koniambo on the west coast.

The principal mining companies are Le Société Nickel and the Société d'Exploitation des Mines de Nickel. The properties worked by the former company are all situated on the Thio district, and in 1890-91 produced 32,000 to 33,000 tons of ore, containing 7 per cent. nickel, whilst in 1892 and 1893 their output is stated to have been 40,000 tons. Besides these two companies, there are several sm ll ventures.

Le Société Nickel buys all the ore mine n New Caledonia, and owns some 60,000 h tares of mineral land on the island, bu s only working 1,000, from which it is said o have cleared a net profit of more t n frs. 6,000,000 in one year, with a capital st k of frs. 12,720,000.

Norway.

The treatment of the Norwegian ores, wh h consist of nickeliferous pyrites and pyrrho e is confined to hand-picking.

In some rich mines small bodies of ore h e been found carrying 7 per cent. of nickel (, for example at Beirn), and in other places e ore averages about 5½ per cent. of nickel, t ore of this grade may be looked upon as be richer than the ordinary run. First-cl smelting ore can, however, be usually sor l out, running 3½ to 4 per cent. nickel, but bulk of the stone is much lower. In 1 miners were satisfied with a yield of 0·8 to per cent. nickel from the smelting ore, actual assay of which showed 0·9 to 1·5 cent. In later years, since the low-grade mi have been shut down, and hand-sorting h been conducted with more care, the yield h increased, varying from 1·4 to 1·5 nickel, least, to 2·5 per cent., or on an average of 2 per cent.

The cost of producing ore of this 2 per ce grade varies from $1·67 to $3·09, averagi $2·38. One kilogram of nickel in the therefore costs 10·71 to 14·28 cents; the sm quantity of copper contained in the ore bei reckoned free. In a few mines operated o large scale the cost may be as low as 7·14 9·52 cents.

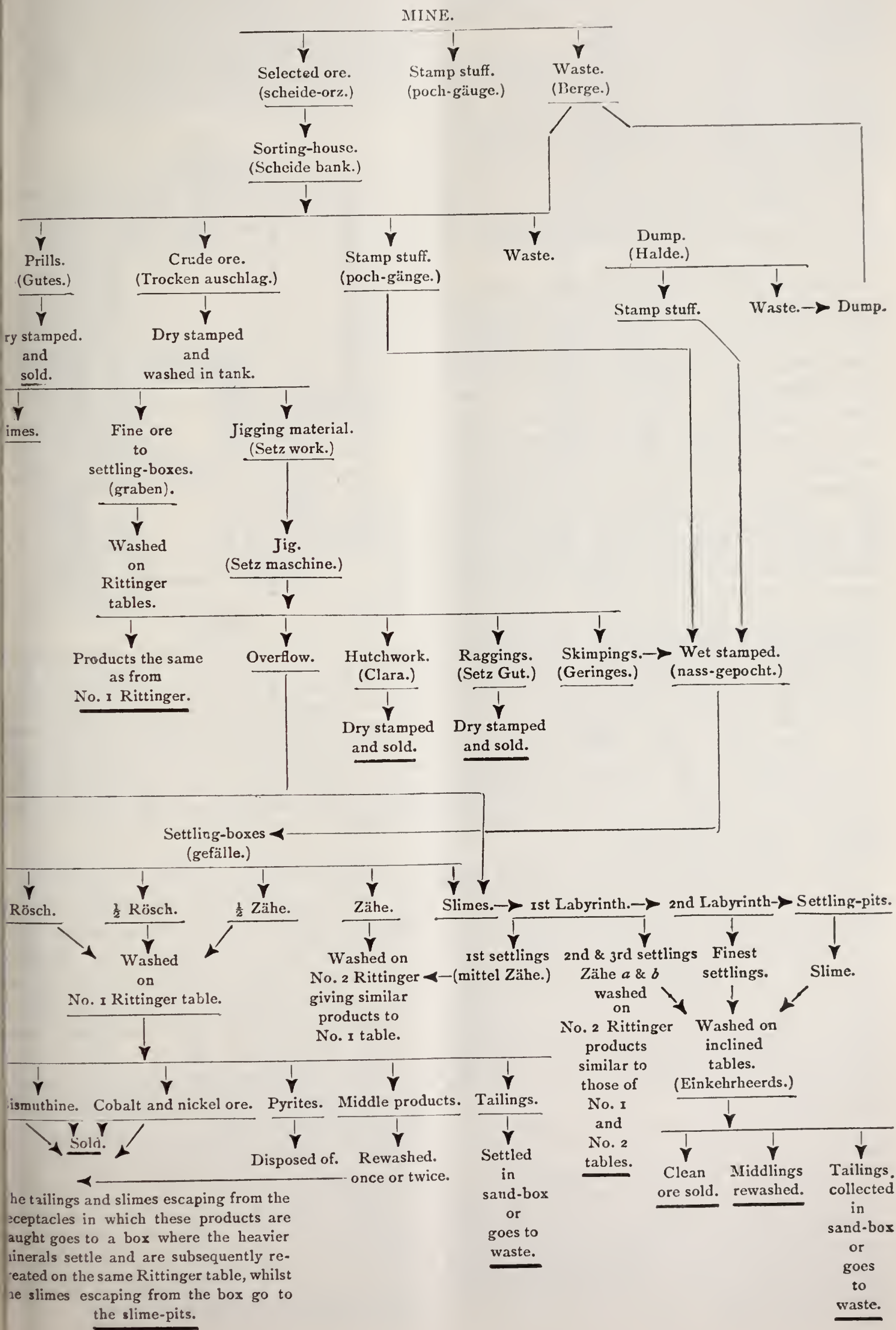
The introduction of modern metallurgi methods would doubtless impart more stimu to the Norwegian industry than it at pres possesses. The maximum output of the mir worked in Norway was 42,550 tons in 18 Since that time the production has only be from 5,000 to 19,000 tons per annum.

Germany.

The only locality I am acquainted w where "dressing," properly so called, largely applied to the treatment of nickel is the Schneeberg district in the Harz, and I have never come across any detailed descri tion of the process, the following account o compiled from notes which I took some yea ago, may be of interest.

NICKEL.—SCHEME OF DRESSING THE SCHNEEBERG ORE.

(Composition 4–6 °/₀, Nickel 3 °/₀, Bismuth 8–10 °/₀.)



The ore averages 3 per cent. of nickel, 4 to 6 per cent. of cobalt, and 8 to 10 per cent. of bismuth, associated with pyrites, and the process it undergoes is illustrated by the accompanying scheme (page 613), which traces graphically the various steps by which the finished products are obtained.

The ore, it will be observed, is separated in the mine into three classes—selected ore (*scheideerz*), stamp stuff (*pochgänge*), and waste (*berge*), and on reaching the surface is further picked over, the selected ore in a sorting-house (Scheide bank), and the stamp stuff separated from the selected ore and waste underground on the dump (Halde) in the open air.

The separation in the sorting-house gives (1) prills (*gutes*), (2) crude ore (*trocken ausch-lag*), (3) stamp-stuff (*pochgänge*), and (4 waste (*berge*). The separation of the stamp stuff (consisting of the mine fines) which takes place on the dump, merely consists in picking out any lumps of waste which were overlooked underground. Both the prills and the crude ore obtained from the sorting-house are stamped dry, to pass a one c.m. mesh screen; but whilst the prills are sent direct to the smelter, the crude ore is delivered from the stamps, through a shoot (*a*, Fig. 1) in the wall of the stamp mill, and falls into a tank (*b*), provided with a sloping bottom. At the deep end of this tank a wooden pipe (*n*) discharges a stream of water on to the ore from an orifice cut in it near the bottom, measuring 10 c.m. by 5 c.m., and, after filling the tank, the water flows out at the other end through a gateway flush with the top of the sloping bottom, thus carrying off the finer and lighter particles of the ore and waste.

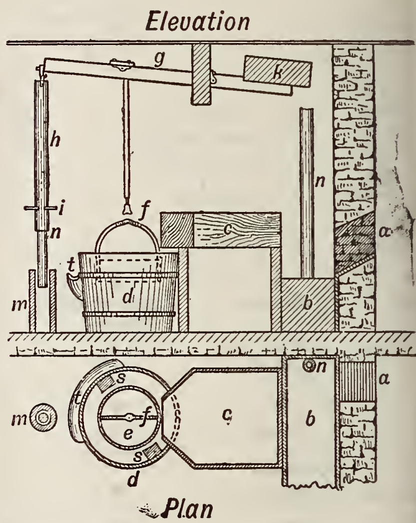
These are concentrated in a series of four settling boxes (*graben*) which connect with a labyrinth in which the slimes are caught. The four settling boxes (Fig. 2) are arranged side by side at right angles to the washing-tank (*a*), and are 3 metres long, 37 c.m. broad, and 37 c.m. deep, and the material collected in them is subsequently washed on the Rittinger percussion table, numbered 2 and 3 on the general plan.

The treatment of the slimes will be described later.

The coarse ore (*setz-werk*) remaining in the washing-tank, after being cleansed of sand and slime by the force of the current of water passing through it, is shovelled out into the feeding box (*c*, Fig. 1) of a hand jig (hand setz maschine), *d*.

The products yielded by this machine ar (1) hutchwork (*clara*), consisting of fine or that passes through the sieve, which is dry stamped and sent to the smelter; ragging (*setz gut*), composed of the lowest layer of or on the sieve bottom, which is dry-stamped like the hutchwork, and sold; (3) skimping (*geringen* or *graupen*), which are scraped o the top of the raggings, and stamped wet.

Fig. 1.



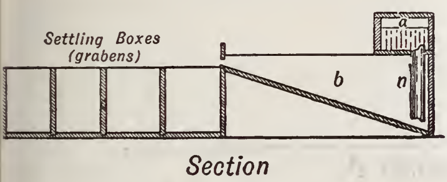
a, shoot for delivery of ore, after it is dry stamped; *b* washing tank; *c*, feed box jig; *d*, circular hand jig; *e* pan of jig carrying sieve; *f*, stirrup and rod; *g*, bean carrying counterpoise; *h*, pole, with cross handle (*i*); *k* couuterweight, consisting of a wooden box filled with stones *m*, hollow wooden guide; *n*, wooden water pipe; *o*, tw square wooden posts, fixed to the ceiling, between which works; *r*, shoulder-pipe on pole (*h*); *s s*, chocks acting a guide for jig; *t*, wooden gutter outside of tub (*d*), to carr off overflow which escapes through a hole in the side.

The jig is a very primitive contrivance o its kind, consisting of a circular tub (*d*) strapped with iron, filled with water, in which a wooden pan (*e*), 54 c.m. in diameter and 12 c.m. deep, provided at the bottom with a sieve, 25 meshes to the square inch, i worked up and down, being connected by a an iron stirrup and rod (*f*), with a beam (*g*), which is depressed by hand by means of pole (*h*), provided with a cross-handle (*i*), an raised on the up-stroke of a counter-weight (*k*) To regulate the length of stroke, the lower en of the pole (*h*) is of a smaller diameter tha the upper portion, and works in a hollo wooden guide (*m*), set in the ground; th shoulder (*r*) on the pole, when it strikes th top of the guide, preventing the sieve fron being plunged too deep in the water.

The pan of the jig, with the stirrup which ıpports it, can be disconnected from the rod ›nnecting with the working beam by a thumb :rew. As the diameter of the pan is con- derably less than that of the tub on which it orks, which is 79 c.m. in diameter, and 65 m. deep, it has to be guided in the latter by /o chooks of wood (*s s*), which run from top bottom of the tub, and are nailed to the des.

Referring back to the scheme of treatment tammbaum), it will be seen that the slimes" produced in the foregoing opera- ›ns (derived from the washing-tank and jig) in those produced in wet stamping the re- ainder of the stone which constitutes the ılk of the crude ore. We have, therefore, ıly to follow the process to which the stamp uff (*pochgänge*) is subjected, whether sorted ıt on the dump, or in the sorting-house, consisting of skimpings from the ore which quires to be jigged.

FIG. 2.

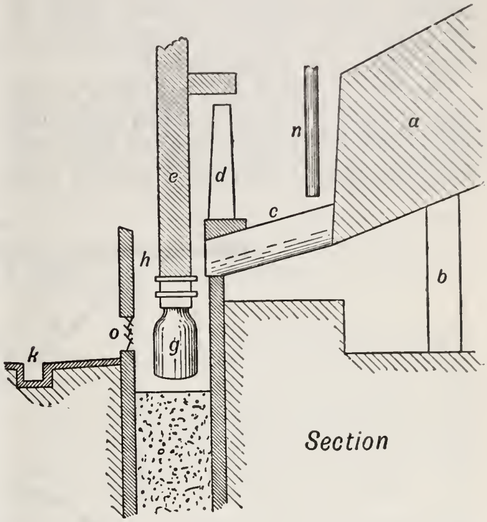


The wet stamping of the ore is effected at ese works in two separate buildings. The ›per stamp-house contains nine stamps, ıich are supplied with ore through a shoot nnected with the dump, where the stone is :ked over, whilst the lower stamp-house is t apart for the treatment of the ore from the ; and that from the sorting-house, which is ought in by a tram line at the level of the ɔ floor, and dumped through shoots into the ımp bins. This lower building is provided th a battery of six wet crushing stamps and ree heads set apart for dry crushing, the ject of which has been already explained.

The stamps in both houses are set in tteries of three. The two batteries of fifteen ads put through 800 to 1,000 lbs. per hour, ch head, weighing 100 lbs., and the stems o to 250 lbs., so that the total effective ight of the stamp is 300 to 350 lbs. The ight of the lift is 12 inches, and the depth of scharge 6 to 8 inches. The battery screens e of wire cloth, ½ m.m. mesh, *i.e.*, six holes the linear centimetre.

The design of the batteries for wet stamping e ore is of the ordinary old-fashioned German type, the general construction of which is shown in the accompanyiug figure.

FIG 3.



a, ore-bin; *b*, wooden support; *c*, feed shoot; *d*, mop which shakes the ore out of the shoot by the blow of the tappet (*'d*) at the back of the stamp stem; *e*, stamp stem (a square wooden beam); *g*, stamp-head; *h*, mortar and foundation; *k*, the trough for carrying off the pulp; *n*, water tube; *o*, screen.

The wooden cam shaft, which is in front of the stamp stems, is not shown in the diagram.

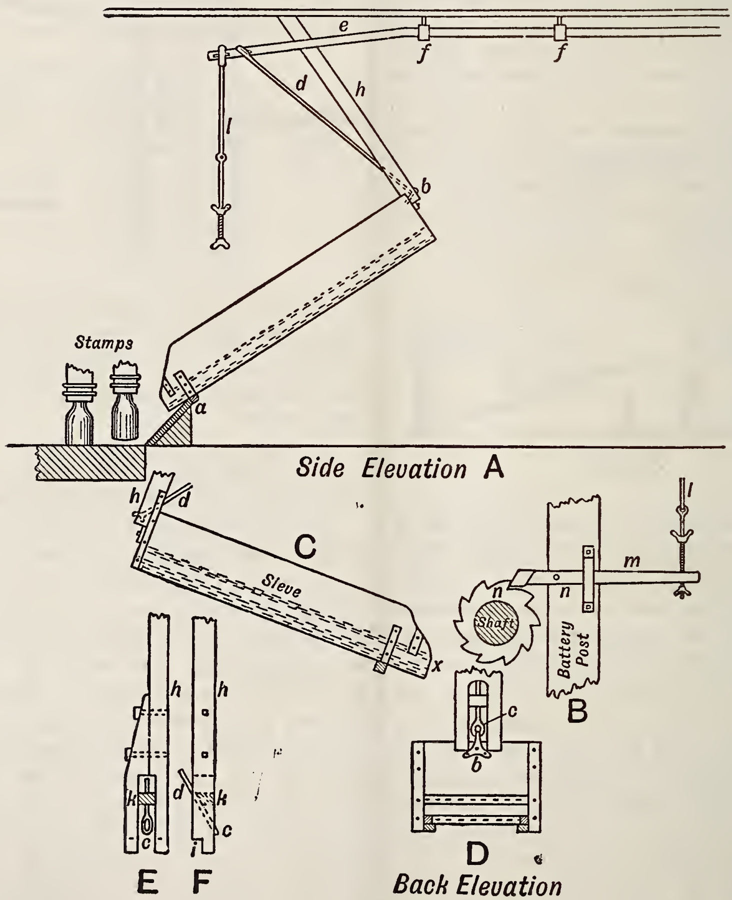
The arrangement is primitive, and "the duty" of such machinery is small, but it must be borne in mind that the lightness of the stamps renders them more suitable for the pulverisation of ore which has afterwards to be concentrated, than would be the case if heavy Californian stamps were used. An iron battery, with light revolving stamps, built on modern lines of construction, would no doubt, however, be an improvement, and such batteries are being introduced at mills like the new central works at Freiberg, but the introduction of such machinery in the older German dressing works has been delayed owing to the fact that a battery like the one described, can be built by workmen out of materials at hand on the spot, obviating the necessity of the extra capital outlay in purchasing it from makers of mining machinery.

The limits of this paper will not permit me to discuss the vexed question as to whether a suitable type of granulating-mill might not be advantageously substituted for stamps in a case like this, where the ore has to be crushed wet and afterwards concentrated. The battery of dry stamps, to which reference has been

made (which is in the lower stamp-house), like the wet stamps is of the usual German pattern, which is shown in the accompanying diagram, Fig. 4, the only point out of the common which deserves notice, being the arrangement for sieving the stamped ore, so as to reduce it to proper fineness.

The side elevation, Fig. 4A, shows a cross piece of wood (*a*), which is nailed to the under side of the sieve-frame, near its lower end. This rests against the edge of a shoot, which returns the ore to the battery if it is n stamped fine enough to pass through the siev as it is thrown upon the latter with a shovel l a workman from the front of the batter which is open and flush with the floor. A ho (*b*) is bolted to the back of the sieve-fram and this catches in an iron loop (*c*, Fig. 4D) the end of a rod (*d*) connected with a wood spring-pole (*e*, Fig. 4A). This spring-pole firmly attached by two iron sockets (*f f*, Fi 4A) to the ceiling of the battery-house, and i

FIG. 4.



tendency is to lift the upper end of the sieve in the direction of the arrow, but the extent to which the sieve can be raised, is limited by the length of the sloping bumping-timber (*h*), which is held in a fixed position at its upper end, whilst its lower end bears against the back of the sieve-frame if raised high enough (as shown in Fig. 4ACD) to enter the recess (*i*, Fig. 4F). To guide it into this position, and to prevent any lateral movement, the bumping timber (*h*) is forked at its lower end, and a block of wood (*k*) inserted in the fork presse constantly on its under side against the ro (*d*), forcing the back of the sieve-frame to trave constantly in a given path.

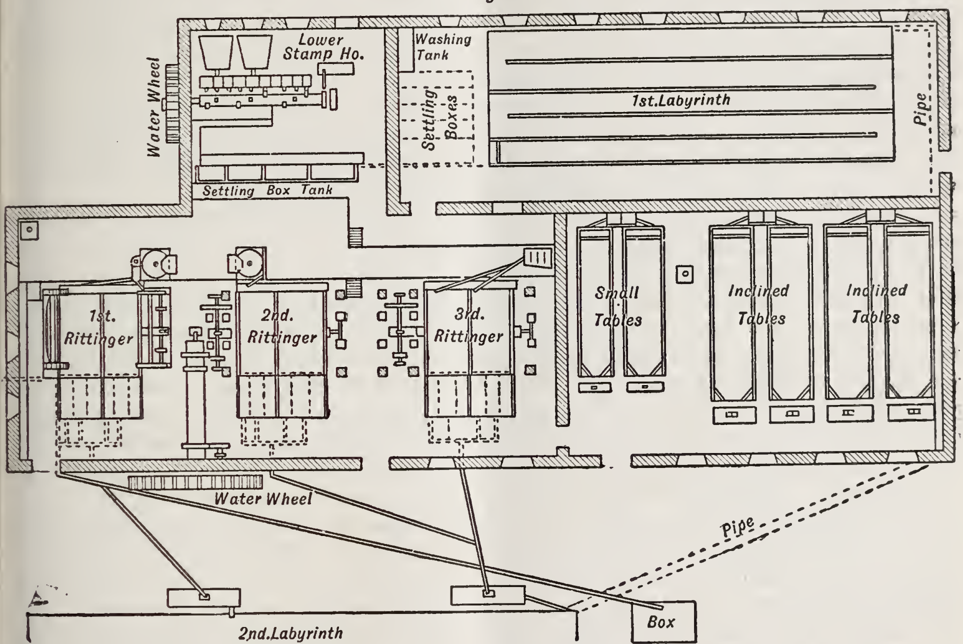
By depressing the end of the spring-pole and then allowing it to exert its upwar tendency, a sharp blow is struck on the back of the sieve the moment it comes in contac with the end of the bumping-bar, and by a rapid repetition of these blows, the ore is rapidly passed through the sieve or returned

the stamps. To produce this action an iron l (l, Fig. 4A) is fixed to the outer end of the ·ing-pole (e), and its other end is attached thumbscrews to a lever (m, Fig. 3B) when : stamps are set in operation. The lever) is pivoted on a fulcrum (n, Fig. 4B), and rks up and down in a guide (p) bolted to e of the battery posts, whilst the end in nt of the battery is provided with a cam, iich fits into the recesses of a toothed oden wheel (r, Fig. 4B), concentric with and ed to the shaft that carries the cams which ise the stamp heads.

The rotation of the cam-shaft in the direc-n of the arrow depresses the end of the spring-pole to the depth of the teeth on the wheel which actuates the lever, and as the cam at its end falls into the depression at the back of the next tooth, the pole brings the end of the sieve-frame sharply back against the end of the bumping-bar, an action which is rapidly and constantly repeated so long as the cam-shaft revolves, and is connected up with the spring-pole rod.

The sieve-frame is provided with a permanent sieve, with meshes 1 c.m. square, through which the crude ore (*trocken auschlag*) is passed, and this serves to protect a finer sieve (x, Fig. 4C), which is slipped under it in a frame which slides in a groove, when ore is

FIG. 5.



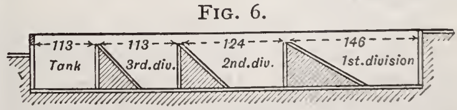
General Plan of the Works

eing crushed for delivery to the smelter. The ne sieve has 14 meshes to the linear inch, nd is 6 to 7 c.m. below the top screen. The ieve-frame is 140 c.m. long, and 38 c.m. road, the actual area of each sieve being 10 c.m. by 30 c.m. The iron die of the dry tamps is 33 c.m. broad, and 33 c.m. deep, nd it lasts 5 to 6 years.

Turning to the general plan of the works Fig. 5), it will be seen that "the pulp," fter leaving the stamps, runs through a aunder into a settling-box (*gefällc*), Fig. 6, which, owing to a peculiarity in its construc-ion, demands a moment's notice.

As is usually the case in Germany each division presents a slope to the flow of ore, but in this particular instance the bottom half of each compartment is flat, and it is the only

FIG. 6.



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one of its kind I have seen out of many dozens of such boxes which I have examined. The first division of this box is 146 c.m. long, the second 124 c.m., and the third division 113 c.m.

in length. The depth and breadth of all the divisions being 43 c.m.

This simple appliance divides the sands escaping from the stamp battery into three divisions, distingushed as *rösch*, *halb rösch*, and *halb zähe*, which are treated separately on the first Rittinger percussion table shown on general plan which is set specially apart for them.

The pulp sufficiently light to be carried over the end of the third compartment of the settling-box falls into a settling-tank (*graben*), which has the same dimensions as the third compartment of the settling-box, but has a flat bottom throughout. The settlings (*zähe*) from this tank are treated on the second Rittinger percussion-table shown on the general plan. A trough under the floor carries the overflow from the last tank into an adjoining part of the building, where it joins the overflow from the washing-tank (Fig. 1 and 2), and settles according to the size and specific gravity of the particles of ore in suspension in the water in one or other of the five divisions of a "labyrinth" (*mehl fuhrung*), which is of the old type with square instead of rounded corners; sixteen inches from the head of the first division, a board five inches wide is set vertically across the box just below the surface of the water, so as to check the flow of the current, and with the same object, similar planks spaced three metres apart, are placed in each division 6 c.m. below the surface of the water, one being fixed at the end of each compartment, The length of all the divisions of this labyrinth are all the same, viz., 12½ metres, whilst their depth is 52 c.m., but their breadth varies; that of the first being 45 c.m., of the second 55 c.m., of the third 60 c.m., of the fourth 70 c.m., and of the fifth 75 c.m. The settlings from the first division (*mittel zähe*) are worked by themselves on the same Rittinger percussion table (No. 2) as that used for the material collected in the preceding settling-box, whilst the ore deposited in the second and third divisions of the labyrinth goes for treatment together to the third Rittinger table.

The settlings from the last two divisions of the labyrinth are worked on inclined tables (*einkehr heerds*). After passing through the labyrinth just referred to, the slimes flow underground through a long pipe to a second labyrinth outside the building, shown on the general plan. The second labyrinth is 9½ metres long and 40 c.m. deep. It is boarded over and divided into sixteen divisions, each 54 c.m. broad. The settl
collected in it are worked on two small
clined tables in the centre of the build
shown on the general plan.

Any ore sufficiently light to be carried
of the end of the second labyrinth, is caugh
the settling-pit (*sumpf*) next to it. This c
sists of a wooden box boarded over, divi
into two compartments 7¼ metres square,
53 c.m. deep, the contents of which is wor
on the large-size inclined tables on which
settlings from the last two divisions of the
labyrinth are treated. Any slime that esca
from this settling-pit is allowed to escape.

The coarse sands, *rösch*, *halb rösch*, *h*
zähe, and *zähe*, caught in the first serie
settling-boxes, are dug out with a sho
piled in separate heaps, and allowed to dr
previous to being treated on the Rittin
table.

Before describing the construction of th
tables, it may be well to glance for a mom
at the work effected by them, and the circu
stances which influence it.

If the "pulp" delivered at the head of
table is of a suitable character, and of e
composition, it will be noticed that as it p
gresses down the bed of the table, particles
a similar character collect together, and
various minerals present in the ore disas
ciate themselves from one another; this acti
becomes more and more strongly marked
the material progresses further and furt
from the point of delivery upon the bed of t
table, the consequence being that the co
stituents of the ore, which vary from o
another in specific gravity, form themsel
into separate distinct bands, travelling do
the bed of the machine in a series of curv
lines, which, though narrow at first, broad
out towards the lower end of the table, whe
they each occupy a certain portion of
breadth, and, dropping over the end, fall in
different receptacles placed underneath
catch them.

The number of the bands on the bed of t
table, depends on the nature of the ore unde
going treatment, and on the relative differen
in specific gravity of its various mineral co
stituents, and the width of each band
mineral where it is discharged at the foot
the table varies very little so long as t
relative per-centage of the various miner
contained in the pulp, does not alter. T
position of the different bands with referen
to one another never alters, so long as t
table is working properly, although one

ier may be partially or entirely displaced by alteration in the composition of the pulp through defective manipulation they may come intermixed. At the time the author ide these notes the grade of ore which was ing treated yielded at the foot of the table e distinct products: (1) a band of sulphide bismuth, (2) about 4 inches of ore consisting an intermixture of sulphides of cobalt and ckel, (3) about 10½ inches of pyrites, (4) some ½ inches of a middle product (*repetition*), d (5) waste, which occupied the rest of the dth of the table.

The two first products are at once saleable, e subsequent separation of the constituent etals of the first one being effected at the ielting works (*hütte*). The third or middle oduct is re-washed as a rule by itself once iich gives saleable "headings," pyrites, &c., iilst the waste (*berge*) is allowed to flow vay as tailings, unless required as sand for iilding purposes, when they are caught in iat is called a sand-box. (See general plan.)

The receptacles in which the ore, pyrites, id middle products, are caught, consist of ixes sunk in the ground, into which the rious products are conducted separately moveable wooden shoots; the water which llects with the ore being discharged from em through three holes bored at different vels in the end of each tank, which are successively plugged up as the tank fills. As rticles of ore, &c., are, however, liable to be rried out with the overflow, to prevent loss is led through a special launder to a box itside the building the overflow of which is scharged into the settling-pit. This catch-ix, which measures 5 metres by 1½ metres id in 75 centimetres deep, is kept padlocked, e discharge from the launder, entering it rough a hole in the cover.

A similar box collects the overflow from e ore-boxes connected with the other two ittinger tables, but with this difference, that iy ore escaping from it passes through a pe into the second labyrinth. The stamp-uff (crushed wet) is reckoned to contain on e average 1 to 1½ per cent. of mineral, id nearly two-thirds of it settles in the first ree settling-boxes and settling-tank which ecede the first labyrinth.

The following practical working details are orth bearing in mind. The poorer the ore, e more rapidly it should be fed on to the ble, and the coarser the material, the greater iould be the inclination of the bed.

Treating coarse sands (*rösch*), the table should be given a slope of from 6 to 6¼ inches in a length of 49 inches; treating medium coarse sand (*halb rösch*) it should be given an inclination of 5½ inches in a length of 49 inches; treating medium fine sands (*halb zähe*) it should be given an inclination of 5 inches in a length of 49 inches; treating fine sands (*zähe*) it should be given an inclination of 4½ inches; and treating the finest sands collected in the two first divisions of the first labyrinth it should be given an inclination of 4 inches in a length of 49 inches.

The blow which the frame of the table receives, should be a sharp and decided one, differing essentially from that of an ordinary end blow percussion table, as in the latter case the table rebounds against the striking block before it is pushed forward again, producing a quivering motion on the surface of the table. In running a Rittinger table it is also of importance that the length of stroke and strength of this blow should be carefully regulated by means of the spring which governs them.

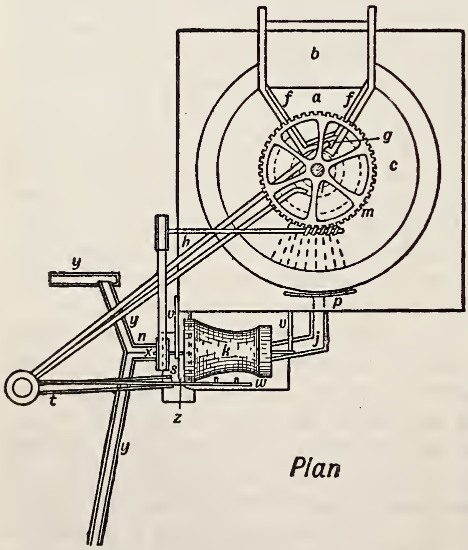
When coarse sands, medium coarse sands, medium fine sands, and fine sands, are being treated, the length of stroke varies from 1 to 1½ inches, and with still finer material it is between ½ and ¾ of an inch. With the first four sorts of material above mentioned, the table is run at from 190 to 210 blows per minute, and with the two other kinds 220 blows per minute are given. Each of the first four classes of sand before being delivered on to the table is thoroughly mixed in an apparatus known as a *dreh-scheibe* in order to insure perfect uniformity of composition and regularity of feed, but the finest sands from the two first divisions of the labyrinth, require to be mixed in what is called a *ruhrwerk*.

The regulation of the supply of clear water is also a matter of the highest importance, and if we denote the amount delivered from the tap nearest the point of the table where the ore is delivered as x, that supplied by the tap in the middle should be about $2x$, and that from the tap on the furthest side should be $4x$. If too much clear water is allowed to flow on to the table near the point where the ore is fed on to the bed, the whole of the material is washed away, before the constituent minerals have a chance of separating themselves from one another. If on the other hand the supply of clear water is insufficient, the sands get mixed with the ore, and the result is that you do not get a proper clean separation. With an excess of water delivered from the

middle tap the same thing happens lower down the bed of the table, whilst if too much water escapes from the further tap, the sulphides of nickel, cobalt, and bismuth, get mixed up with the pyrites and middle product, *per contra* with too little the waste gets mixed with the middle product and pyrites.

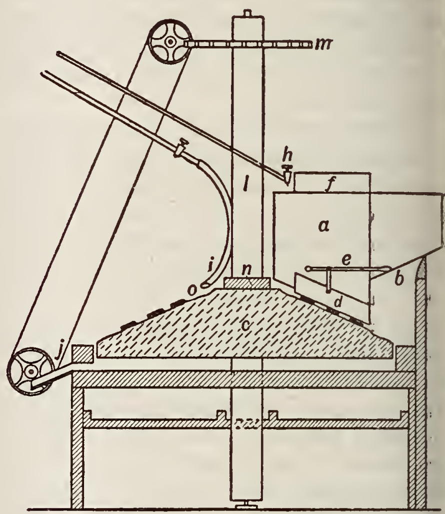
With a very smooth surface, such as a bed of glass or marble, the author considers that the ore is washed down too easily, and the most satisfactory material seems to be maple wood. Success would also appear to depend in a large measure on having the power devoted to driving the tables well under control, as any unevenness in running (such as would be caused by stopping or starting other machines driven by the same motor) is fatal to good work. Another matter of moment is the delivery of the ore at the Schneeberg works, either a teazer or mixer (*dreh-scheibe*) is employed for this purpose. The construction of the latter machine will be plain from the following drawings. After the ore has been allowed to drain, as previously described, it is shovelled into the feed-box (*a*, Fig. 7 and 9) of the machine, which is filled nearly to the top if need be with ore.

Fig. 7.



The back part of the feed-box is provided with a sloping bottom (*b*, Figs. 7 and 8) forming a kind of hopper, but the front portion is open; the consequence is that the charge of ore contained in the box rests upon the conical circular table (*c*) underneath. One side of the box is cut away so as to form an opening corresponding in length with the radius of the table, three-quarters of an inc in height, the height of the opening bein reduced, if necessary, by a sheet of iro (*d*, Fig. 8), which serves the purpose of door, regulating the amount of ore which ca pass out of the box as the table revolves. I is raised or lowered by a handle (*e*, Fig. 8)

Fig. 8.

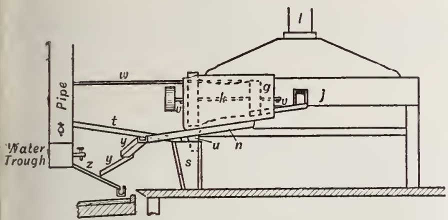


Section

A false lining (*f*, Figs. 7 and 8) prevents th ore, when the box is full, from falling over th sides, and a space (*g*, Fig. 7) left in on corner forms a channel for the introduction o a small stream of water, which is supplie from a pipe (*h*, Fig. 7) fitted with a tap t regulate the supply, which is merely a dribble By this means, as the table revolves in th direction of the arrow towards the open side o the hopper, it carries a thin layer of moist ore of even depth, out of the feed-box, coverin the whole surface of the table and clinging t it till washed off by a strong jet of wate issuing from a pipe (*i*, Figs. 7 and 8), whic sweeps it off and washes it down through th trough (*j*, Figs. 7, 8, and 9) into the revolvin screen (*k*, Figs. 7 and 9). The table is sup ported upon a vertical post 18 c.m. in diamete (*l*, Figs. 7, 8, and 9), which is rotated b means of a toothed wheel (*m*, Figs. 7 and 8) actuated by worm gearing, threaded so as t make five turns round the shaft. Where th post passes through the table, it is encircle by a ring of wood (*n*) 3 c.m. broad and 4 c.m high, resting on a ring of sheet-iron, whic projects 3 c.m. beyond it; encircling thi there is a shallow gutter (*o*) 8 c.m. wide, from

e outer edge of which the working surface ' the table slopes away at a sharp angle, as ıown in the section (Fig. 8), for a length of 3 c.m. This part of the table is studded with rips of iron, 5 c.m. long and 3 m.m. high, riven into the wood and arranged in rows ıdiating from the central post. Each row which contains three strips) is so arranged ıat the spaces between the ends of the strips ome opposite to slips in the rows on either

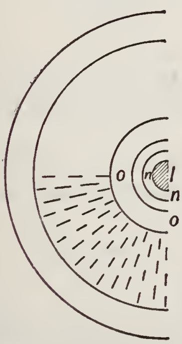
FIG. 9.



Side Elevation

ide (Fig. 10). The 53 rows of slips, which ach table carries, are spaced $2\frac{1}{2}$ c.m. apart, nd the wood between the rows is slightly ollowed out, forming a series of shallow adiating gutters. The outer edge of the able beyond is sloped away, as shown in the ections. The movable bed of the turntable evolves five times in four minutes, and is set ı a fixed outer table, the top of which is

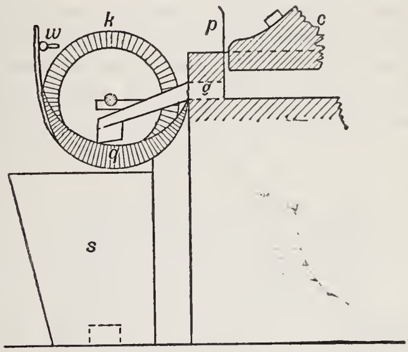
FIG. 10.



horizontal and slightly higher than the edge of the interior one (Fig. 11), with a space of about 5 m.m. between the two.

The pipe (*i*, Fig. 7 and 11), which is of lead, has an opening $2\frac{1}{4}$ c.m. long, and 3-4 m.m. broad, and is set at a point of the table opposite to the hopper, with its nozzle pointing down the slope of the bed, an iron shield (*p*, Fig. 7 and 8), nailed to the inside of the fixed table, preventing the water from overflowing. The ore as it is washed off the table passes through the trough (*j*, Fig. 7, 8, and 9) into the revolving drum (*k*, Fig. 7 and 9), which is 17 c.m. in diameter at one end, and 24 c.m. at the other. Most of the ore which passes through the sieve falls into the outer sheet-iron casing (*q*, Fig. 7, 9, and 11), from which it is conducted by a wooden launder (*r*, Fig. 7, 9, and 11) to the Rittinger tables. Any ore, and chips of wood, &c., that will not pass the screen, which has 196 holes per square inch, are discharged into a shoot (*s*, Fig. 7, 9, and 11), 18 c.m. long and 20 c.m. broad, from the end of the drum, which projects beyond the sheet-iron casing. A perforated zinc screen is fixed in the mouth of the shoot (*s*) to catch chips, &c., and any ore

FIG. 11.



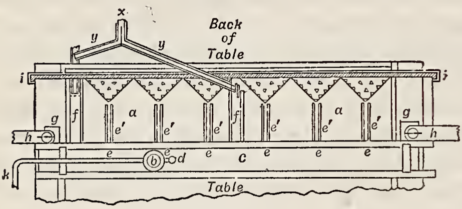
Section

passing through this screen is swept away to the waste dump by a rapid stream of water introduced into the shoot by the launder (*t*, Fig. 7). A zinc funnel (*u*, Fig. 7 and 9), which has two spouts, bridges over the launder (*r*, Fig. 7, 9, and 11), and directs the rejections from the drum into the shoot *s*. The drum rests on bearings, supported on square wrought-iron bars (*v v*, Fig. 7 and 9), and is driven by a small pulley, 23 c.m. diameter, keyed to its axis, and two jets of water play constantly on the outside from the pipe (*w*, Fig. 7, 9, and 11). The stream of ore discharged from the drum is split in two by a sheet of zinc (*x*, Fig. 7), and is carried down the launders (*y y*, Fig. 7) direct to the pegging-boards (*happen-brett*, *z*, Fig. 9) of each double Rittinger table. The construction of these pegging-boards is shown in Fig. 12.

It consists of a sloping board (*a*), on which are set a number of triangular pegs of wood, about $1\frac{1}{2}$ c.m. high, each of which turns on a nail, by which it is fastened to the board, so that the space between the pegs can be ad-

justed within certain limits, varying from 3 to 6 m.m., the object of this being to distribute an even sheet of clear water over the edge of the board on to the surface of the table. The water is supplied through a pipe (*b*), from a trough (*c*) (see Figs. 9 and 12), the inflow being regulated by a tap (*d*, Fig. 12).

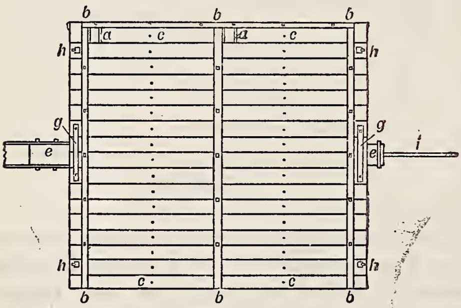
FIG. 12.



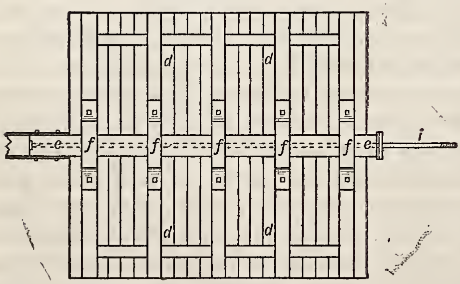
Plan

The trough is about 30 c.m. deep, and is provided with six small delivery taps, which discharge the water into six small launders (*e e e e e e*)—formed by nailing short strips of wood to the pegging-board—at the apex of the

FIG. 13.



Plan



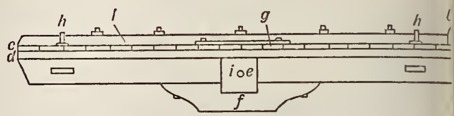
Plan

FIG. 14.

pegs, which are arranged in sets to form a series of six triangles, three of which distribute the water to one-half of a double table, and three to the other half; but, as before explained, the amount of water delivered from each tap has to be carefully adjusted. The stream of ore is delivered on to the peggin board of each double table, at the points (*j* Fig. 12), where two gutters are fixed to dire it on to the table, and prevent it from gettii mixed with the clear water; *g g*, Fig. 12, a holes cut in the pegging-board, to allow wrought-iron link hung from the arm of t

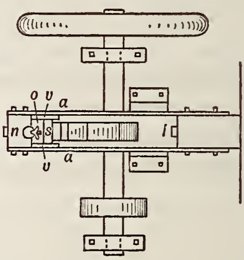
FIG. 15.

Side Elevation



cast-iron supports (*h h*, Fig. 12) to have fr play, and swing backwards or forwards wit out touching the pegging-board, which stationery. This link supports the moveab bed of the table, and its length can be alter

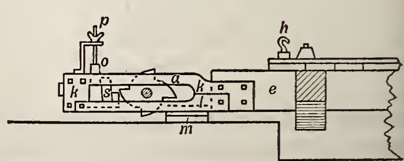
FIG. 16.



by screwing up the thumb-screws (Fig. 13 so as to adjust the inclination of the bed the table.

The ore and clear water falling over th edge of the pegging-board drops through

FIG. 17.

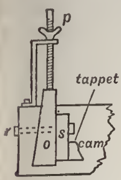


Side Elevation

long narrow sieve (*i*, Fig. 12), placed imm diately under it, and falls on to the bed of th table. A pipe (*k*, Fig. 12) conveys a strea of clear water into a trough at the foot of th table, to assist in washing away the tailing The construction of the bed of the tables

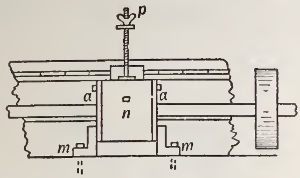
ıown in the seven figures numbered 13, 14, ;, 16, 17, 18, and 19.

Fig. 18.



Section

Fig. 19.



End Elevation

ig. 13 is a plan of the frame of the table.

,, 14 is a plan of the underside, showing how it is braced together.

,, 15 is an end elevation of the side of the table.

,, 16 is a plan of the general arrangement (cam-cam shafts, &c.), for imparting motion to the table.

,, 17 is side elevation of the above, with the fly-wheel, driving-pulley, and bearings omitted.

,, 18 is a section, on an enlarged scale, taken of the centre of the striking block.

,, 19 is an end elevation of Figs. 16 and 17, taken inside the bearings, which carry the cam-shaft.

The tables at Schneeberg, are made of maple ıcer *plakoites*) and had been running for even years when I took these notes. As will e seen from Fig. 13 the working surface of he bed is divided into two equal parts by a atton or rib of wood which runs down the niddle, forming a double table, the sides of vhich are formed by two similar ribs 10 c.m. listant from the edges of the bed, and upon ach half a similar separation takes place. 'hese middle and side battens are about 9 c.m. igh and 7 c.m. broad, and are fastened to the ›ed with glue, and further secured with five iron ag screws. A fourth batten 6 c.m. broad and o c.m. high (see Fig. 15), similarly fixed down, orms the back of the table. Four small slips ›f wood, $3\frac{1}{2}$ c.m. high and $2\frac{1}{2}$ c.m. broad, ıailed down on the bed, form small receptacles *a*, *a*, Fig. 13), which prevent the ore from nixing with the clear water before it has time o travel a short distance down the bed of the wo halves of the table.

The side, middle, and end battoes (*b*, *b*, *b*, *b*, Fig. 13 and 15) rest on a bed of carefully planed (maple) planks (*c*, *c*, Fig. 15), laid ıcross a foundation of deal planks (*d*, *d*, Fig. 15), which run lengthways down the table. A sheet of tarred and greased sail cloth being spread between the top and bottom planking. The lower bed of deals is nailed to a frame-work of square timber halved into the centre longitudinal timbers, and morticed into the two side timbers.

The bumping beam (*e*, Fig. 13, 14, and 15), which is 18 c.m. square, and crosses the centre of the table, is halved into the longitudinal timbers and held fast by chocks of wood (*f*, *f*, *f*, *f*, *f*, Fig. 14 and 15) firmly bolted to the frame, the bolts in the two outside pieces being secured to two plates (*g*, *g*, Fig. 13 and 15) of iron one on each side of the table.

The bumping beam projects 25 c.m. outside of the frame of the table on the cam shaft side, and 10 c.m. on the opposite side, and the short end which receives the blow, is strengthened by being bound round with a wrought-iron band to prevent it slipping, whilst the longer end has a couple of plates of wrought-iron (*a*, *a*, Fig. 16, 17, and 19) (carrying the tappet shown in Fig. 18) bolted one on each side of it.

The longitudinal timbers, as well as the chocks which secure the bumping-beam to them, are 12 c.m. deep and 10 c.m. in width, whilst the cross-timbers halved into the longitudinals (25 c.m. from the top and bottom of the table), which bind the framing together, are 10 c.m. by 10 c.m. The planking is held down upon this framework by the battens at the sides and middle, which are firmly screwed to the centre and side-pieces of the frame, and to make all secure a copper nail is driven through each plank into the two intermediate timbers.

The table is hung from 4 wrought-iron hooks (*h*, *h*, *h*, *h*, Fig. 13, 15, 17), which are bolted to the framing, 25 c.m. from the top and bottom of the table. A wrought-iron bar (*i*, Fig. 13, 14, 15), $2\frac{1}{2}$ c.m. diameter, passes through the centre of the bumping-beam, and at the cam-shaft side of the table ends in a square-headed nut, which is counter sunk in the wood. The other end of the bar projects some 6 ft. or more beyond the opposite end of the bumping-beam, to allow of its attachment to the spring which causes it to rebound. The means by which motion is imparted to the table is shown in detail in Figs. 16, 17, 18, 19. The arrangement consists of two plates of wrought-iron, which are bolted to the sides of the short end of the bumping-beam; each plate is made into two pieces (*k*, *l*, Fig. 17), and is so shaped that there is a long, narrow opening left in the centre of each side, the object of which is to give room for the cam-shaft to pass through them, whilst it allows the plates to travel freely backwards and forwards in a horizontal plane between the cast-

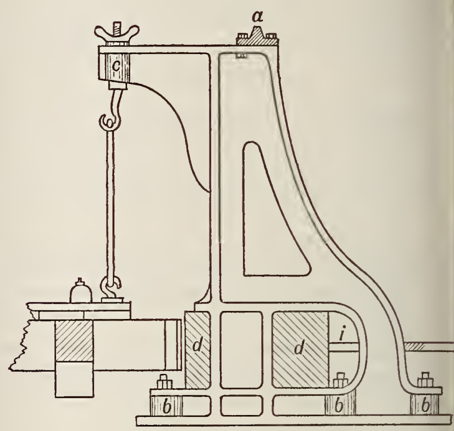
iron guides (*m*, *m*, Figs. 17 and 19). The outer ends of the plates are connected by a solid block of wood (*n*, Figs. 16 and 19), to which is attached the ingenious tappet arrangement shown in Figs. 16, 17, and 18, which regulates the length of stroke of the table.

This consists of a fork-shaped wooden wedge (*o*, Fig. 16, 17, 18) which can be raised or lowered by the thumb-screw (*p*). The front of this wedge which faces the table, is vertical, but the back is sloped to correspond with a seat cut in the block (*n*), so that the front of the wedge can be pushed forward or drawn back by screwing it up or down; a groove in the centre permits the free passage of a screw-bolt (*r*, Fig. 18), the nut of which is countersunk in the end of the block, *n* (Fig. 19). The bolt in question holds a second block of wood (*s*, Fig. 18) against the face of the wedge, *o*, and has to be loosened or tightened according as *o* is raised or lowered. The actual cam, which is also of wood but which is narrower than *s*, is dovetailed into the front of the latter; *v*, *v*, Fig. 16, are wooden guides, the wedge *o* and the block *s* being narrower than the block *n*.

Motion is imparted to the table in the direction of the arrow by the cam, *w*, which is keyed to the cam-shaft, *x*, the cam as it revolves bearing against the "shaped" face of the tappet. The cam shafting, which is $3\frac{1}{2}$ c.m. in diameter, carries a fly-wheel (*y*) 80 c.m. in diameter, 8 c.m. wide, with a rim 9 c.m. deep, as well as a driving pulley, *z*; it runs in bearings (*w*, *w*, Fig. 16) fixed inside the cast iron supports on which the table is hung. The guides, *m*, *m*, are bolted to a concrete foundation. The bed of the table is 2·60 m. long, and each half of the working surface is 1·25 m. broad. A sheet of zinc, about 4 c.m. wide, is nailed along the foot of the table on the under side of the planking, projecting 2 c.m. beyond the framing. The supports from which the table is hung are shown in Figs. 20, 22, and 23.

Figs. 20 and 22 are an elevation and plan of the cast-iron supports on the further side of the table from the cam-shaft. The shaded parts are about 2 c.m. thick, and they are connected in pairs by a cast-iron cross-piece (*a*, Fig. 23), which is bolted-on on top of them. *b*, *b*, *b*, Fig. 20, are round enlargements of the main casting, bored for the holding-down-bolts which fasten the supports to the concrete foundations; *c*, Fig. 20, is a similar boss bored for the bolt, from which the table is suspended; *d*, Figs. 20 and 21, is a solid block of wood let into the cast-iron supports at each end, and bound round with two wrought iron straps (*e*, *e*, Fig. 23), and it is against this block that the bumping-beam (*e*, Figs. 13 and 15) strikes. The bar (*i*, Figs. 13, 14, 1[illegible] 20, and 21) passes through a hole bored in the

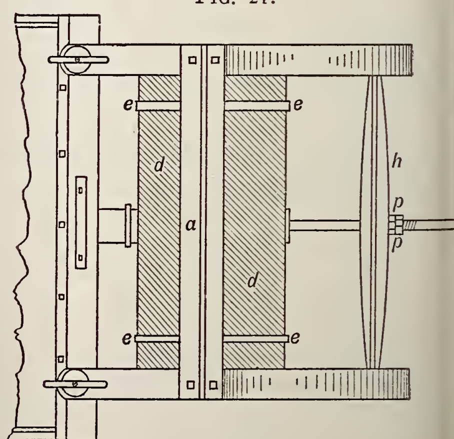
FIG. 20.



Elevation

bumping-block (*d*, Figs. 20 and 21), which is protected from undue wear by an iron face plate and a plate at the back, beyond which the bar (*i*) is secured to the wooden spring (*h*, Fig. 21), which is shown in front elevation

FIG. 21.

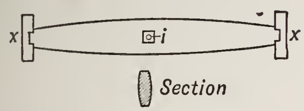


Plan

and section in Fig. 22 by two lock-nuts (*p*, Fig. 21). The function of the spring is to cause the rebound of the table, and it is held in place at each end by two plates of wood (*x*, *x*, Fig. 22), which are firmly wedged into recesses in the back of the cast-iron supports

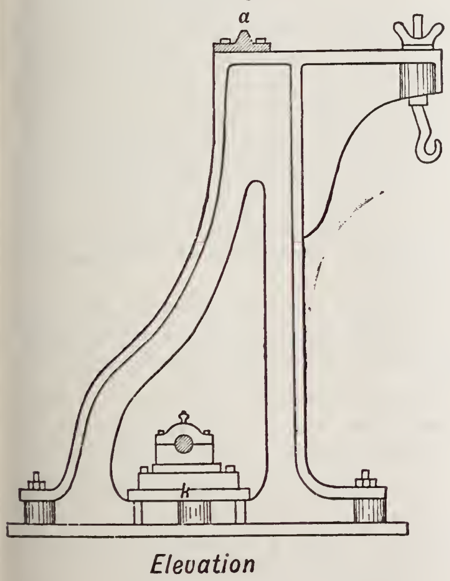
:hind the bumping-block. Fig. 23 is a side evation of one of the supports on the cam ıaft side of the table, which are of the same :ight, but differ in shape from those just :scribed, the centre of the castings being ore open, and having a foot-plate (*k*, Fig. 23) ıst at the base of each, to carry the plummer-locks, which serve as bearings for the cam ıafting.

FIG. 22.



I have entered into considerable detail in de-cribing these works for several reasons. In the rst place they illustrate a point to which, not un-equently, insufficient attention is paid in lay-ıg out dressing-plant, the necessity of careful izing of sands and slimes previous to their treat-ıent on tables. It is true that the method of oing this at Schneeberg may appear some-/hat crude, and would doubtless be improved pon in modernized works, by the substitution

FIG. 23.



of automatic hydraulic-classifiers for the old-fashioned labarynths and settlers; but, for all that, the work done in this old-fashioned German *wäshe* is very close and good, and it serves, I think, as a useful lesson; showing the importance of the point which I have just laid stress upon.

In the second place, whilst I do not for one moment wish to contend, that the Rittinger table is unrivalled as a concentrator, for dealing even with material which it is most fitted to treat, as it is a machine which requires proportionately a large amount of power to do a given amount of work; still, I believe that, for handling coarse and medium coarse sands, where you have to separate a complex ore, containing a combination of minerals, it is capable of yielding a very clean product, and doing close work. Its performance, however, depends on the amount of care given to a number of small and apparently trifling details, and want of attention to some one or other of them, has I am satisfied been the cause of failure, in cases where concentrators of this kind have proved inefficient, a remark which, though it applies equally, in many other cases, to mining machinery, is perhaps worth laying special stress upon, when operating concentrators of this class.

In modern Continental mills, the Lührig and other concentrators have largely taken the place of the Rittinger, as they do not require nearly so much power to run them, whilst, for dealing with slimes, the old-inclined tables used at Schneeberg, could not, of course, bear even the slightest comparison with an efficient slime-table like the Linkenbach buddle.

The Schneeberg mill is, however, a unique and highly interesting instance of practice, which, though now out of date, has given, commercially, satisfactory results, within comparatively recent times.

NICKELIFEROUS PYRRHOTITE.

Before quitting the subject of "dressing" ores of nickel, I should like to call attention to a new method which it is proposed to apply to the treatment of Canadian nickeliferous pyrites. I allude to the possibility of concentrating it by means of a magnetic separation. Dr. Stephen H. Emmens discusses this question in a paper published in the journal of the American Chemical Society, vol. xiv., No. 10. He points out that nickeliferous pyrrhotite is invariably described in text-books as a mineral consisting of an iron sulphide in which "part of the iron is replaced by nickel."

He mentions that the general formula for pyrrhotite is $Fe_n\ S_n + 1$, which is sometimes written n (Fe S). Fe S_2 or n (Fe S). $Fe_2\ S_3$, but expresses the opinion that the more correct view is to regard the typical compound $Fe_3\ S_4$, as being a homogenous body and not composed of a mixture of sulphides. For reasons

refer to *Journal of Analytical and Applied Chemistry*, vol. vi., No. 10, Oct., 1892.

This question, however, is comparatively unimportant in the present discussion, as, whatever may be the precise arrangement of the molecules, their number will not be changed and pyrrhotite will still be defined as an iron sulphide composed of n molecules of Fe and $n + 1$ molecules of S. On the "replacement" theory, nickeliferous pyrrhotite will be a sulphide composed of x molecules of Ni $n - x$ molecules of Fe and $n + 1$ molecules of S

According to figures given by Dr. Emmens, this numerical theory does not accord with analysis and it would appear from them that the formula $(Fe\ Ni)_n\ S_{n+1}$ inapplicable to various samples analysed by him.

In each case sulphur was found to be in excess, in varying proportions which appear to bear a definite relation to the per-centage of nickel present in the sample. The lower the nickel contents the greater being the surplus of sulphur, and *vice versa*. This Dr. Emmens remarks "necessarily follows from the great size of the compound molecule when the percentage of nickel is small. If, however, we investigate the proportion borne by the sulphur to the total metal, we shall find a tendency to constancy rather than to variation." This is shown in a table given by him, which suggests that the composition of nickeliferous pyrrhotite is polymeric; and, taken as a whole, the results of the analysis are, he points out, opposed to any assumption of homogenity of structure. Coming now to physical investigation, Dr. Emmens goes on to say that "we are at once met by a feature that is conclusive against the hypothesis of "replacement" and homogenity. I allude to the fact that nickeliferous pyrrhotite may be divided into two portions, one of which is magnetic, the other non-magnetic.

In 1879 Habermehl effected a separation of the magnetic from the non-magnetic portions of pyrrhotite, for the purpose of obtaining a pure mineral for analysis.

In 1890, T. J. McTighe applied magnetic separation to the treatment of the nickeliferous pyrrhotite of Canada, and subsequently T. A. Edison applied for a United States patent in respect of virtually the same invention, and filed a specification containing the following statement:—"I have discovered that where magnetic pyrite called 'pyrrhotite' is nickeliferous as it usually is to a more or less extent, the nickel is not distributed generally through the whole body of the pyrrhotite, but certain crystals are pure pyrrhotite, or magnetic pyrites, while other crystals have some of the iron replaced by nickel, and sometimes by cobalt, and that the crystals containing the nickel or cobalt are considerably less magnetic than the pure pyrrhotite." Dr. Emmens traverses this statement, observing that, "pyrrhotite is rarely found in a crystalline form, and that crystals of nickeliferous pyrrhotite are as yet unrecorded as having been observed." Mr. Edison's mention of "crystals" being probably only a loose way of describing the minute fragments, particles, or grains, into which the massive pyrrhotite is divided by communication.

"Dr. Emmens' observations do not confirm the statement that nickeliferous pyrrhotite can be magnetically separated into nickeliferous and non-nickeliferous portions." A separation into two very distinct minerals, or mineral mixtures, is possible, and these contain very distinct percentages of nickel, but both are nickeliferous.

A comparison of the results obtained by the magnetic treatment of samples of pyrrhotite from the Lancaster Gap Mine and from a Sudbury mine, made in Dr. Emmens' laboratory, coupled with the analysis previously alluded to made by Dana, show conclusively that the magnetic minerals are of the pyrrhotite type, but that the non-magnetic concentrates are of quite dissimilar constitution, and as the latter are much higher in nickel than the former, it is also clear that the nickel is not present as an element replacing iron in pyrrhotite.

Dr. Emmens considers that we may regard the minerals under discussion provisionally as represented by the following formulæ:—

Crystalline pyrrhotite, n (Fe_3S_4).
Amorphous ,, n (Fe S) x $(Fe\ S_2)$.
Nickeliferous ,, n (Fe S x Fe S_2) y (Ni S).

In conclusion, in regard to the practical problem of magnetic concentration of nickeliferous pyrrhotite, two samples analysed by Mr. Mixer gave the following results:—

	Gap. Per cent.		Sudbury. Per cent.
1. Division of the total sample:—			
Magnetic portion........	58·66	....	92·95
Feelby magnetic portion..	6·67	....	2·09
Non ,, ,, ..	34·67	....	4·96
2. Division of the total nickel contents:—			
Magnetic portion........	16·25	....	58·01
Feelby magnetic portion..	19·96	....	7·60
Non ,, ,, ..	63·79	....	34·39

	Gap. Per cent.		Sudbury Per cent.
Total gangue in sample :—			
Gap	41·28	....	
Sudbury	10·7	....	
Division of the total gangue :—			
Magnetic portion	25·85	....	75·51
Feelby magnetic portion	7·12	....	9·07
Non „ „	67·03	....	15·42
Per-centages of gangue in the portions :—			
Magnetic portion	18·20	....	8·70
Feelby magnetic portion	44·00	....	46·60
Non „ „	79·80	....	33·20

The practical inferences from these figures re as follows :—

(1) Magnetic separation will give a rich ickel concentrate.

(2) An ore with considerable gangue will ield more of its nickel as "concentrate" ıan will be the case with cleaner ore.

(3) The concentrate from clean ore will be f higher grade than one carrying much angue.

(4) The nickeliferous portion of the mineral attached to the gangue more firmly than is ıe non-nickeliferous portion.

(5) The nickel is possibly *an essential ele- ıent of the gangue instead of being a onstituent of the pyrrhotite.*

This last inference, Dr. Emmens remarks, s so opposed to generally-received teachings, ıat further investigations are needed, and ave been instituted by him, to determine its orrectness or otherwise, but results so far eem to favour the supposition of the gangue eing nickeliferous. He inclines to the belief he magnetic concentration of nickel ores is ikely to be introduced into Canada at no listant date. According to the same authority obalt appears to be present in quite unusual bundance in the Drury matte, in which he ound some manganese together with a new ubstance, which, if not, a hitherto, unknown ıltotropic modification of nickel or cobalt, is a ıew metal.

SMELTING.—TREATMENT OF THE NICKEL COBALT ORES OF NEW CALEDONIA.

As a considerable amount of nickel ore xported from New Caledonia contains cobalt, vhich is recovered as a bye product, the nethod by which the two methods are sepa- ated is of interest, and will be first described.

The ore in question is said to have approxi- nately the following composition :—Peroxide of manganese 18 per cent.; peroxide of cobalt 3 per cent.; peroxide of nickel 1·25 per cent.; silica 8 per cent.; ferric oxide 30 per cent.; alumina 5 per cent.; lime 1 per cent.; magnesia 1 per cent.; moisture, &c., 32·75 per cent.

It is shipped to France, where it is treated at the Maletra Works, Rouen, by a new and ingenious process, particulars of which are given in the United States Consular Reports, September, 1891, from which the following abstract given in the "Mineral Industry," 1892, is taken :—

"The mineral in a state of powder is thrown into large vats filled with a solution of proto-sulphate of iron, and thoroughly mixed by a jet of steam. The manganese, the cobalt, and the nickel are taken up by the liquid in the form of sulphates. The iron that is in the mineral, as well as that in the solution, is precipitated in the form of peroxide and partly as persulphate with the alumina and silica. The liquid (containing in solution the manganese, cobalt, and nickel) is drawn off, and the residue (containing iron and alumina) is passed through a filter-press and, after calcination, may be used as colcothar. The proto-sulphate of iron used in this operation is made in the establishment by attacking scrap-iron with one of the residues rich in sulphuric acid known as bi-sulphate of soda. This bi-sulphate of soda forms with scrap-iron proto-sulphate of iron, and also sulphate of soda used subsequently. The sulphate of soda is separated by crystallization. The liquid containing the manganese, cobalt, and nickel, is run into stone basins, to which is added sulphide of sodium, which precipitates the whole of the cobalt and nickel but leaves the greater part of the manganese in solution. The sulphide of sodium is produced in the establishment by boiling in a closed vessel one of the bye-products—black-ash waste from the carbonate of soda furnaces—and sulphate of soda residue from the making of the proto-sulphate of iron already described.

"The precipitate containing the cobalt, nickel, and a small quantity of manganese, is washed, passed through the filter-press, and then treated with perchloride of iron (produced in one of the succeeding operations), which dissolves the manganese. This second operation gives (1) a black precipitate of comparatively pure sulphides of cobalt and nickel, and (2) a liquid containing sulphate and chloride of manganese. To the liquid is added chloride of lime obtained in one of the subsequent operations, and the manganese, precipitated by the lime, becomes a bye-product, which is used in the Weldon process.

"The third operation consists of drying the sulphides of cobalt and nickel, and then carefully roasting them in a reverberatory furnace, when, if carefully done, the sulphides of the two metals become soluble sulphates. The fourth operation is the most difficult. The soluble sulphates are washed with boiling water. The solution is treated with chloride of calcium. Of the solution (*a*) containing chloride

of cobalt and nickel a certain quantity is taken, and the cobalt and nickel are precipitated by lime. This precipitate of oxide of nickel and cobalt is washed to remove any chloride of calcium that might remain, then placed in a suitable vessel, a sufficient quantity of water added, and submitted to a current of chlorine gas and air under pressure to produce a thorough mixing. To the peroxides so obtained is added a new portion (*b*) of the liquid (*a*), and the two being mixed up thoroughly by a jet of steam, a curious change takes place. The peroxide of nickel changing into protoxide enters into solution, and is displaced continuously by an equivalent proportion of cobalt from the first solution. The liquid then contains choloride of nickel, the cobalt being precipitated as peroxide of cobalt. The second portion (*b*) is calculated so as not to displace the whole of the nickel. This liquid is now run off, and a fresh quantity of *a* added, and so on until on testing it is found that the precipitate contains nothing but peroxide of cobalt when the operation is finished. The solutions containing nickcl are treated with lime, and the nickel precipitated as oxide. The products of the operation are (1) protoxide of nickel, (2) peroxide of cobalt, (3) chloride of calcium. The choride of calcium is required in one of the preceding operations. The separated oxides of nickel and cobalt are filter-pressed, dried, and calcined."

The Maletra Company treats at present about 150 tons of ore per month, containing 3 per cent. cobalt and $1\frac{1}{4}$ per cent. nickel. The total exports of cobalt ore from New Caledonia, from 1875 to 1892, have been 24,938 metric tons. During the past few years the exports have ranged from 2,500 to 4,000 tons per annum. The total production of cobalt in the world is about 200 tons per annum. Its principal use is in the manufacture of a pigment, of an intense and unchangeable blue, which is largely applied in tinting porcelain.

Treatment of Garnierite (hydrated silicate of nickel and magnesium).*

The treatment of this mineral has undergone several modifications before arriving at the present practice. The original plan of Mons. Garnier was to treat it like iron ore by running it into pig-metal, which was afterwards to be refined in a reverberatory furnace to ferro-nickel. For this purpose two blast-furnaces were built at Noumea, and a refinery, with two Siemens furnaces, at Septimes, near Marseilles. Only the first part of the process gave satisfactory results, practically all the nickel and iron being g out, and a good ferro-nickel being obtain from the richer lumps, but this was attend with a large loss of iron and nickel in the sla formed, treating ores averaging 9 to 10 p cent. of nickel. The resulting product show the following composition :—Nickel, 65 to (per cent.; iron, 29·5 to 23·0; sulphur, 1·5 2·5; silica and carbon, 3·5 to 5·0; and oth matters, 1·5 to 2·5.

These experiments led to the formation the Ferro-Nickel Company of France, whic was started by Mons. Marbeau, then one the directors of Le Nickel, and it was throug this that the first nickel-steel was made, th New Caledonian nickel-ore itself being fr from sulphur. But it was found to be im possible to refine this ferro-nickel in the reve beratory furnace, owing to the presence sulphur, which has an extremely high affini for nickel. It was therefore necessary revert to the old method of concentrating th metal as sulphide by the addition of pyrites sulphur. The average composition of the o available for smelting was—Silica, 45 to 50 iron, 16 to 14; nickel, 8 to 7; magnesia, 1 to 10; alumina, 3 to 5; water and oxygen, 1 to 14 per cent.

This requires from 25 to 30 per cent. bases (oxide of iron or limestone) besides sulphurising material. As neither gypsum n pyrites, free from arsenic and copper, wer available for the latter purpose, the charg for the blast furnace was made up as follows ore 1,000, coral 300, sulphur 35, small coal coke 75 kilos. The greater part of the sulph passed into the regulus and a fluid slag wa obtained with 48 per cent. of silica, 12 to 1 per cent. of iron, and not more than 0·40 t 0·45 per cent. of nickel; but the local smeltin was given up owing to the difficulties in pro curing coke, and now the New Caledonia ores are for the most part smelted in Europ alkali waste or salt cake being used as a flu

The composition of the ore as given b Dr. J. H. Emmens is—nickel 0·24 to 35·48 pe cent., magnesia 2·47 to 37·38, silica 35·4 to 66·97, alumina and iron oxide 0·11 to 15·13 lime nil to 1·90, sulphuric anhydride nil to 38 water 5·27 to 17·75.

The consumption of coke is about 20 pe cent. of the weight of the charge, or abou 30 per cent. of that of the ore treated. Smal sized water-jacket cupolas smelting from 2 to 30 tons in 24 hours are used. The produc contains nickel 50 to 55 per cent., iron 25 t 30, and sulphur 16 to 18, the latter bein

* Abstract of a description given by Mons. Levat in a general memoire on the production and uses of nickel and its alloys, in the "Annales des Mines, Paris," 1892, published by the authority of the Minister of Public Works.

·cessary to make the regulus sufficiently ·ittle to be easily powdered. The subsequent ›ncentration may be done either in the re- ·rberatory furnace or the Bessemer converter. ı the former case the two calcinations, ıllowed by fusion with quartz-sand, are ecessary for the removal of the iron.

The furnace treats two tons in 24 hours, ith the consumption of the same weight of ›al. The operation, which lasts eight hours, controlled by sampling during its progress, nd is stopped when the iron has completely isappeared in order to prevent the loss of ickel in the slags, which, however, are not ırown away but are returned to the ore- ırnace, as they form an excellent flux, besides ›ntaining 2½ per cent. of nickel.

By the first concentration the iron is reduced › 2·5 to 3·0 per cent. and by the second to ·5 to 0·75 per cent., the sulphur being kept › 16 per cent. at least. In the Bessemer ›nverter the concentration is more rapidly one; a charge of one ton of regulus melted ı a cupola is introduced into the converter, nd blown with air at a pressure of 40 centi- ıetres of mercury. The temperature rises ·om the combustion of the sulphur, and sand ; introduced to flux the iron. If the propor- ion of the latter metal does not exceed 36 per ent. it may be completely removed in about hour and 20 minutes, but with a larger quan- ty the bath should be skimmed after blowing ›r 25 minutes, and a fresh flux added, as the ning will be imperfectly done if too large a uantity of slag is retained in the converter. Vhen the slag begins to show signs of con- aining nickel oxide, the refined metal is ·oured into moulds. Arsenic, antimony, and ulphur are removed either in the slags or by he blast, the cobalt remains with the nickel ulphide. The converter slags are much richer han those of the reverberatory furnace, con- aining from 14 to 15 per cent. of nickel, mostly ıs shots of diffused regulus, which may in ›art be collected by running the slag into ·onical pots, and separating the cake of metal ıt the bottom. The whole of it must, in any ·ase, be returned to the ore furnace. Attempts ıave been made to continue the blowing-up to ·ompletely remove the sulphur, to produce a naterial that would only require a final reduc- ng treatment to obtain pure nickel. This has, ıowever, been found to be impossible, owing o the high affinity of nickel for sulphur, the ıeat developed in such an after-blow being ess than sufficient to counteract the cooling ·ffect of the air, and as the product, when free from copper, has a high melting point approximating to that of iron, it sets very rapidly, and blocks up the tuyeres.

The refined regulus, whether obtained from the reverberatory furnace or the converter, consists essentially of nickel sulphide (or nickel and copper sulphides if obtained from pyritic ore like that of Canada) with not more than 0·50 per cent. of iron, and the same proportion of other foreign matters. It is crushed to pass a 65 mesh sieve, and charged in quantities of 600 kilos upon the bed of a reverberatory calciner, 10 metres long, and 2·50 metres broad, with four working doors on one side, forming a layer about 2 inches thick, which is constantly rabbled and moved gradually from the flue to the fire-bridge end. The operation lasts 8 hours with pure nickel sulphide, and only six when the regulus contains copper.

The consumption of coal is 2,000 kilos for 2,400 kilos of material roasted. The temperature is kept to a dull redness, except towards the end, when the furnace is raised to a bright red heat. The finished product, which should not contain more than one per cent. of sulphur, is ground to pass a sieve of 120 mesh, and subjected to dead-roasting in a furnace of the same breadth as the preceding one, but with a shorter bed. The charge is 500 kilos, renewed every six hours, and the temperature is kept at bright redness; three tons of coal are burnt in 24 hours. The product is nickel-oxide, or nickel and copper oxides, and should not contain more than 0·40 per cent. of sulphur. The reduction of the oxide is effected by mixing it to a paste with flour or other organic matter, dividing into small pieces, when dried, and strongly heating with charcoal powder. Formerly the paste was cut into cubes of 12 to 15 millimetres, but in France discs of regular shape, 50 millimetres in diameter and about 15 millimetres thick, made in a press, are prepared. They must not be made thicker, or the reduction will be imperfect in the centre.

The Chinese, who are considerable consumers of nickel, prefer to have it moulded into ingots, similar to those used as money in China. Formerly, the reduction was effected in crucibles, holding 50 to 60 kilos, in a reverberatory furnace, but, owing to the imperfect and irregular heating, the process was very wasteful of fuel, and the pots did not last for more than five or six operations. The method has, therefore, been abandoned in favour of furnaces working continuously. The first of these is a large muffel, 3·5 metres long and 1·8 metres broad, heated by the flame of a gas

furnace, which is passed several times around it by a series of spiral flues. The shorter sides are closed by balanced doors, and the iron pots, containing a mixture of oxide and charcoal, are subjected to a gradually increasing heat for 24 hours, entering at the coolest side, and being pushed gradually nearer to the fireplace. This, mixed with oxides, gives a coherent product; but pure nickel oxide, though it is reduced by carbon at a comparatively low temperature, must be subjected to a temperature of 1,100° or 1,200° for four hours, to obtain the coherent metallic character required by the customer; and as such heat is unattainable in the muffle, the operation must be finished in a crucible.

Another and more improved plan of reduction is in a regenerative furnace resembling that used for reducing zinc oxide in Belgium, but having retorts open at each end. The mixture of oxide and charcoal is charged by a semi-circular scoop at one end, and when finished the charge is pushed out at the other end into closed receivers, where it is allowed to cool out of contact with the air. A furnace with 22 retorts is capable of reducing 1,500 kilos of nickel-oxide, or 3,000 kilos of nickel-copper oxides in 24 hours, the charge of 750 or 800 kilos requiring ten hours in the furnace in the first and five hours in the second case.

About two tons of coal are required for heating in the 24 hours, and the work is done by two men per shift of 12 hours. The reduced metal is sifted to separate the cubes or discs from irregular or broken pieces, which are afterwards collected by a magnet. The former are polished by friction upon each other in a rapidly rotating barrel, while the latter is added in packing the barrels to make up the exact weight of 100 kilos. It is probable that the total cost of the New Caledonia ore delivered at the French or Scotch reduction works is not less than \$20 per ton, freight being a heavy item. As, however, it contains an average of 10 per cent., whereas the Canadian pyrrhotite averages 2·62 per cent., reckoning the cost of the latter delivered at the "breaker" at \$5 per ton the prime cost of the ore at the smelting works is about the same in both cases, viz., 10 cents per lb.

For the production of one ton of nickel oxide, containing say 76 per cent. of nickel, the cost in the case of the New Caledonia ore may be estimated as follows:—

Smelting for matte, 7·6 tons at \$2·50 = \$19·00; first calcination, 2·0 tons at \$1·25 = \$2·50; first fusion, 2·00 tons at \$3·54 = \$7·08; second calcination (the number of calcinations at tl stage sometimes amounts to five), 1·75 tons \$1·25 = \$2·19; second fusion, 1·75 tons \$3·54 = \$6·20; pulverisation of refined su phide, \$0·50; first roast of refined sulphid \$5·00; second pulverisation, \$0·50; secon roast, \$5·00; total, \$47·97.

If the oxide is sufficiently pure to require intermediate refining, and if it be run dire into granulated melal by reduction in crucible the cost for crucibles, fuel, charcoal, labo repairs, &c., is about 8 cents per pound nickel produced. Hence the ultimate cost the extraetion of nickel from garnierite about as follows:—Mining and transport, cents; conversion into oxide, 3 cents; redu tion into metal, 8 cents; allowance for lo in working, 1 cent; total, 22 cents.

The reactions which take place in th European method of treating silicated ore imported from New Caledonia, are given i Schedule A (p. 639).

TREATMENT OF ARSENICAL NICKEL ORE

Prior to the discovery of the New Caledoni deposits, ores of this class mined in Europ formed the chief source of the world's suppl The following description of the process given by Professor Roberts-Austen in hi "Introduction to the Study of Metallurgy":- "The wet method for the extraction of nick and cobalt from a complex regulus or arsenid consists, in the first place, of a roastin operation, having for its object the volatilisa tion of the sulphur and arsenic, and it may b antimony and the conversion of the iron nickel, cobalt, and other metals present int oxides."

"Ferric oxide formed in this manner, at high temperature, is but little soluble in acids whilst the other oxides may be readily dis solved. On treating the roasted materia repeatedly with hydrochloric acid, or wit dilute sulphuric acid, a residue is obtained containing but little or no cobalt or nickel and consisting mainly of ferric oxide. Som iron will, however, have passed into solution Should the solution contain lead, bismuth, o copper, these metals may be precipitated by sulphuretted hydrogen, but it is customary t precipitate the copper at a later stage of th operations. The bismuth, too, may be pre cipitated from a hydrochloric solution by dilution with water. The next operation con sists in the precipitation of the iron. Any ferrous oxide which may have passed int solution is converted in ferric oxide by carefu

ldition of chloride of lime, followed by the ldition of lime, which precipitates the iron. rsenate of iron is at the same time also prepitated if arsenic is present. Should the mperature of the solution exceed 40° C. some ckel and cobalt are precipitated, as also in ›me copper.

" Instead of an addition of lime as the prepitant, caustic soda or sodium carbonate is ccasionally employed to prevent the precipition of calcium sulphate. When working ith sulphuric acid solutions care must be ken to avoid using an excess of the prepitant, as the precipitation is a fractional ie and, as soon as the iron has been precipited, oxides of the other metals present begin be thrown down.

"The next stage of the process consists the precipitation of the copper. This is fected by raising the temperature of the ›lution to 70° C., and then precipitating the ›pper by the careful addition of either calcium rbonate, milk of lime, or a solution of soda. an excess of the precipitant is employed, ckel will be thrown down; when a test of potassium ferro-cyanide shows that the whole of the copper has been thrown down, the cobalt is precipitated from the filtered solution by the careful addition of a solution of chloride of lime to the perfectly neutral hot and not too dilute filtrate. If too much chloride of lime is added the precipitate becomes too nickeliferous, and this must be carefully avoided. The nickel is next precipitated, either by calcium carbonate, milk of lime, or soda.

"The nickel hydrate is filtered, dried, heated with sodium carbonate to decompose any calcine sulphate that may be present, washed with acidulated water, and, finally, dried and reduced by carbonaceous materials to the metallic state.

" This process being dependent on the fractional precipitation with the same precipitants of the several metals present in the ore, or metallurgical product under treatment, is frequently subject to slight alterations of procedure, and the following is a description of the process as carried out at works in the United Kingdom.

WET PROCESS FOR EXTRACTING NICKEL AND COBALT.

A
Calcined ore or speise of nickel and cobalt.

B
Granite jar for containing HCl steam passed in.

C
ecipitation of iron and arnic by milk of lime, after roxidising the ferrous oxide $CaOCl_2$ steam passed in.
D
Filter.
E
Solution pumped up to *F*.

F
Precipitation of copper sulphide by sulphuretted hydrogen.
G
Filter.
H
Ni and Co Sol pumped up to *J*

J
Solution carefully mixed with metallic iron, chalk and chloride of lime. Steam passed in, sulphuretted hydrogen evolved.
K
Filter.
L
Stock tank solution pumped up to *M*.

M
Dividing tank heated to 40° Co precipitated by $CaOCl_2$.
N
Filter. Residue Co_2O_3 to market.
O
Nickel ppt. by milk of lime. Precipitate reduced to metallic nickel.

" About 3 cwt. of fine ore or speise, *A*, that is been thoroughly roasted, is charged with ›drochloric acid in granite jars, into which eam is passed. The mass is kept boiling r 12 hours; it is allowed to settle and run f into tubs, *C*. Steam is conducted into the bs, and when the liquid begins to boil, eaching-powder (chloride of lime) is added peroxidize, the iron, and the mass is allowed boil for about 3 hours. The arsenic and on come down together. If no iron be prent in the solution, some must be added. he liquid is then run off through filters, *D*, to underground tanks, *E*, whence it is pumped to tanks, *F*, in which the mass is treated with sulphuretted hydrogen. Adjoining these tanks, of which there are six, there are also three lead retorts, in which sulphuretted hydrogen is produced. In these tanks the copper is precipitated, and the nickel and cobalt solution is strained through filters, *G*, and drains into a second underground tank, *H*. It is then pumped into a tank, *J*, and there successively mixed with iron, chalk, chloride of lime and water, from tubs placed above the tank, with a view to precipitate, first, any

copper that may have passed into solution during filtration, and then the iron, which has taken the place of the copper. The charge is first boiled by the aid of steam-pipes, so as to expel the sulphuretted hydrogen. It is then run off to a tank, *L*, for stock. It is next pumped into a dividing tank, *M*, and heated with chloride of lime, the cobalt being precipitated as oxide at a temperature of 40°. The solution containing nickel is allowed to run off into another tank, *O*, in which milk of lime is added, and the nickel precipitated as hydrated oxide; the liquid is allowed to run off as waste. The oxides are pumped into presses, and the water is drained off. The nickel oxide is dried on the roof of a muffle, heated and crushed; it is then mixed with charcoal and heated in a crucible in a reducing furnace for 8 or 12 hours. A rough powder is obtained, and in this form the metal is sold, or the nickel oxide is mixed into a paste with flour and water, which is heated and cut into cubes. The cubes are placed in crucibles, with charcoal, and heated to a temperature above the melting point of copper. The nickel oxide is reduced by the charcoal and by the carbonized flour; the metal does not melt, but preserves the form of cubes. The cobalt oxide is removed from the dividing tanks to stone jars, and treated by a process similar to that described, so as to remove the last trace of nickel. The cobalt is finally sent to the market in the form of oxide."

It will be readily understood, from the complexity of this process, that it must be an expensive one; hence the high price which fine nickel has maintained. But there are various modifications of the wet process, some of which are of recent invention, and possibly the cost of production may be somewhat reduced by them. One of these is soon to be tested at the village of Port Colborne, at the head of the Welland Canal, where advantage will be taken of the supply of natural gas there for fuel. Gypsum, supplied from mines in the adjoining country of Haldimand, is to be largely used under this method, and hope is entertained that the sulphuric acid obtained as a bye-product will very considerably reduce the cost of producing the refined metal.

As to dry processes, including reduction of oxide by carbon in furnaces or crucibles, and concentration as sulphide or arsenide, and subsequent smelting in reverberatory or blast furnaces, it does not yet appear to be certain that such methods can be successfully and economically applied to the treatment of nicke ores through all stages to the refined metal but the metallurgy of nickel is so recent a subject of investigation and experiment, that thi may be possible at some future time. Authorities on the subject differ as to the possibl scope of the dry process, thus—

Dr. J. H. Emmens, in a letter published i the *New York Mining Journal* of June 3 says:—"No wholly dry process hitherto employed, is capable of separating cobalt, or evei (to a thoroughly satisfactory extent) copper arsenic, and manganese, from nickel;" and referring to the Canadian pyrrhotite ores, "th metal produced by dry method from such raw material is not fitted for fine uses."

Replying to this, Mr. Robert M. Thompson President of the Orford Copper Company, sai (*New York Mining Journal*, June 17th):—"The following assays were made by the sam chemist for nickel:—Wharton's grain nickel 99·39 per cent.; Martino's disc nickel (fines foreign nickel), 99·06 per cent.; Orford nickel produced by exclusively dry process fron Canadian pyrrhotite ores, 99·23 per cent. A to the quality of the Orford nickel, while I d not claim it is yet as perfect, as we hope it soo will be, yet one of the largest consumers i the country writes me—'In some respects, you nickel is superior to any we have ever used. The metal is very white, and remarkably sof and ductile, both of which points are of th greatest value." The reactions which tak place in the ordinary wet method of extractin nickel and cobalt from calcined ores, speiss and matte are shown in Schedule B, p. 640.

Treatment of Cupro-nickeliferous Mattes.

At the St. Denis works in France, belongin to Mons. Christophle et Cie., they treat th ores of New Caledonia conjointly by the dr and wet method, the latter being applicable t the cupro-nickeliferous mattes obtained by first fusion of the ore with pyrites containin copper and nickel. The matte is first attacke with sulphuric acid, utilising the sulphur acid set free for the precipitation of the coppe from the solutions previously obtained. Th iron is precipitated as oxide by means o calcium chloride and an air-blast. Finally the nickel is thrown down as a greenish gela tinous hydrated precipitate with the milk o lime. This oxide can be either utilised for th manufacture of sulphate of nickel destined fo electro-plating or dried calcined, and con

verted in the anhydrous white oxide obtained in the dry way, which can be reduced to metallic nickel.

The trouble with the oxide of nickel precipitated in this way with milk of lime is that it always retains a certain amount of the impurities of the milk of lime employed for its precipitation, and the solution contains sulphates; there is the additional inconvenience which arises from the presence of sulphate of lime dissolved in the water retained by the gelatinous precipitate of the hydrated oxide, which is very voluminous. This salt remains in the nickel throughout the calcination, and introduces during reduction sulphur into the metal.

This latter trouble can be avoided by precipitating the dissolved sulphate of lime with chloride of barium prior to the precipitation of the nickel, or by separating the sulphate of lime after calcination by a crucible fusion with carbonate of soda, but both these methods increase the cost of refining. The difficulties thus introduced of purifying the hydrated gelatinous nickel oxide renders the process inapplicable to the treatment of large quantities, as in order to do so a very large plant, consisting of precipitation vats, washing apparatus, and filter-presses, is required. The product consisting of nickel-oxide pressed in cakes still contains also a large per-cencentage of water.

The *Herrenschmidt process* is designed to overcome this difficulty. The iron contained in the matte being used to precipitate the copper in the form of cement-copper, which only requires refining to be put into merchantable form, whilst the nickel which is contained in residuary concentrated solution is converted into oxide by evaporation and roasting, and finally reduced by the ordinary process.

Treatment of Nickeliferous Pyrrhotite in Canada.

After being sorted, as described on p. 611, the ore is stacked in the roast yards in roast heaps, containing some hundreds of tons. At the Evans Mine space is provided for roasting about a quarter of a million of tons of ore per annum, and the company has usually about 50,000 to 60,000 tons of roasted ore on hand. The ore in the heaps is stacked to a height of 4 feet or 5 feet, on an 18-inch bed of cordwood, it is then covered with a layer of "raggings," and banked at the sides with 6 or 8 inches of "fines." The piles hold 600 to 1,800 tons of ore. Combustion once started is kept up for 6 to 10 weeks, and results in the removal of much of the sulphur, which is lowered to about 7 per cent., a partial oxidation of the iron, and the thorough disintegration of the diorite gangue, owing to the swelling and oxidation of the ore. The roasted ore is next smelted with coke in low blast-furnaces of the Herreschoff pattern, the gangue serving as a sufficient flux, and the product being a regulus of nickel, copper, and iron.

The blast-furnaces are elliptical in shape, 6 feet 6 inches by 3 feet 3 inches, and provided with a water-jacket of boiler iron, 9 feet in height, which extends from the hearth to the charging-door. The plates of this jacket are 3 m.m. thick, with a 2-inch water space, and the furnace is provided with an exterior brick-lined, water-cooled, forehearth or well. The hearth itself is covered by a plate of iron, coated with fireclay. Furnace No. 1, of the Canadian Copper Company, smelted in a run of 259 consecutive days 31,268 tons of ore, an average of 120 tons per 24 hours. No. 2 ran for 73 days, smelting 9,740 tons, or 133 tons in 24 hours. The low height of the furnace prevents the reduction of the iron and the formation of "bears." The coke consumed during the campaign above-mentioned amounted to 5,107 tons, with which 41,000 tons of ore were smelted, representing an average of 12·5 lbs. of coke per 100 lbs. of ore.

The coke, which contains 10 per. cent. of ash, is obtained by lake and rail from Pittsburg, and costs £1 9s. 2d. per ton delivered at the smelters. The matte produced in the same time amounted to 5,059 tons, or about 12 per cent. of the weight of ore smelted. One ton of matte therefore requires for its smelting about 1 ton of coke, and the capacity of each furnace may be reckoned at about 125 tons of ore, yielding 15 tons of matte per 24 hours.

The slag is very base, as the following analysis will show:—

	Per Cent.
SiO_2	38·00
FeO	43·00
CaO	4·50
Al_2O_3	10·00
S	2·00
Ni	·45
Cu	·40
MgO	2·50
	100·85

At first the mattes contained more copper than nickel, which proved disadvantageous in their subsequent treatment, the refiners

charging more as the proportion of the copper exceeded that of the nickel. In 1889 the mattes of the Canadian Copper Company contained according to analysis :—

	Per Cent.
Cu	26·910
Ni	14·140
Fe	31·235
S	26·950
Co	·235
Slag	·935
	100·405

By sorting out the pure copper ores for separate treatment, as previously mentioned, the nickel contents of the matte have been increased. In February, 1891, the mattes contained :—

	Per Cent.	Per Cent.	Per Cent.
Cu	16·94	16·95	17·84
Ni	19·40	21·47	23·45

The charge in the Dominion Mineral Company's furnace is composed purely of nickeliferous ores produced from some of its mines, the matte obtained containing, according to Levat :—

	Per Cent.
Cu	18 to 20
Ni	24 ,, 26

Mr. D. H. Browne, chemist-in-chief of the Canadian Copper Company, states that the average grade of that company's matte is as follows :—

	Per Cent.
Copper	20 to 25
Nickel	18 ,, 23
Iron	25 ,, 35
Sulphur	20 ,, 30

From picked ore cupola matte is sometimes made as high as 52 per cent. of nickel. The grade is made to suit the consumer, some desiring high copper and low nickel, and some low copper and high nickel; any desired proportion of copper and nickel can be made from selected ores. It is interesting to note that, as the mines deepen, the ore alters in character (as pointed out in my paper read last Session) from a distinctively copper ore at the surface, to a distinctively nickel ore at the lower levels. Copper Cliff Mine, for example, produced, on the first level, a chalcopyrite, in which nickel was found by accident, after large shipments of the ore had been made as a copper ore; on the fourth and fifth levels, the ore carried about 4 per cent. Cu. and 8 to 10 per cent. Ni. As these stopes are opened, the cupola matte will be raised thereby to 25 or 30 per cent. nickel.

Two furnaces are always kept running, and the matte is tapped into conical matte-pots, in which it is allowed to cool. The slag runs continuously through a slag-spout at the top of the "well," and during the winter is wheeled away in pots, similar to those used for the matte. In summer, it flows continuously from the well, through an opening in the floor where a powerful steam-jet granulates it, and carries it to the dump, a system devised by Mr. J. McArthur, the General Manager of the Company.

The workmen employed at the furnaces receive, on an average, 7s. 6d. per shift of 8 hours. Each shift at each furnace consists of one foreman, one weigher, two smelters, three men to remove the slag, and three shovellers. The entire plant is so organised that the handling of the ore from the mine to the furnace is reduced to a minimum; in fact, the ore is only handled four times from the mine to the furnace, and each delivery, except to the roast-heaps, is effected, by means of hoppers direct, into waggons. Manual labour, though high, only represents, according to Mr. Levat, 1s. 10½d. to 2s. 1d. of the total cost of smelting a ton of ore. The next step in the process is the refining of the cupola matte. This is effected at the Canadian Copper Company's refinery at Sudbury, where the matte, after being remelted in cupolas, is run into Bessemer converters, similar to those used for refining copper.

There are three converters in the refinery, one being always in use whilst a second is being relined, and the third is in readiness for a charge. The capacity of this plant is equal to about 25 tons of cupola matte, producing 15 tons of Bessemer matte per 24 hours. The converters are lined with silica, which unites with the oxide of iron in the matte to form a slag, while the copper and nickel remain as sulphides. The iron is thus almost entirely removed, the sulphur lowered to from 5 to 15 per cent., and the copper and nickel raised to about 45 and 40 per cent. respectively. As there are none of the usual flame reactions which serve to guide the operation in bessemerising copper, the point at which to stop the blowing, after the iron has been removed, and before the nickel has commenced to slag off in undue amounts, is one in which great skill and judgment are required by the furnace manager.

As the converter slags rarely show over 2 per cent. of copper and 3·5 per cent. of nickel, and as the ratio of copper to nickel in

ie material treated is about 23 to 20, and in ie product 43 to 39, sufficient proof is given f the care exercised in this particular considering the degree of concentration attained, nd the easily oxidisable nature of the material. ll converter slags are returned to the cupolas or re-smelting. For convenience in handling he converter matte is cast in slabs 3 feet quare and about 3 inches thick, weighing bout 1,500 lbs. each. These slabs are lifted n to buggies by the hydraulic cranes which erve to actuate the converters. A fair average nalysis of the Bessemer matte of the Canadian Company is—

Copper	43·36.
Nickel	39·96.
Iron	0·3.
Sulphur	13·76.
Silver..	7 ozs. per ton.
Gold	0·1 to 0·2 ozs. per ton.
Platinum	0·5 ozs. per ton.

After Bessemerising the matte, the process branches into two distinct parts—(1) For the manufacture of copper-nickel alloys (for use in German silver), the Bessemer matte, after roasting to remove all the sulphur, can be reduced to an alloy direct, either by charcoal or by reducing gases. A refined copper-nickel alloy, containing 50 per cent. Cu, and 49 per cent. nickel, with very small amounts of iron, silicon, and carbon, is produced direct from Bessemer matte. The economy to German silver manufacturers of purchasing a ready-made alloy, which melts at a low heat, and requires simply the addition of zinc, instead of buying the nickel and copper separately, is sufficiently obvious. An alloy of this kind, known as "50-50," is almost indistinguishable from pure nickel. Its cost is much less than nickel, and its melting point much lower, and as it can be cast solid in any desired shape, and furnishes a casting which works easily in the lathe or planer, yielding a silvery white surface, unchanged by air or moisture, this alloy seems destined to be widely used in place of brass or nickel plated iron. For the new bullet casings, now used in various British and continental rifles, a special alloy of 80 per cent. lead and 20 per cent. nickel is employed. (2) For the manufacture of pure nickel, the Bessemerised matte is treated in different ways at different works.

(*a*) One method is to calcine it in a reverberatory to remove most of the sulphur, and afterwards chlorodise it by roasting it with salt, the copper chloride being removed by lixiviation. If any considerable amount of iron remains with the nickel the lixiviated material is dried, mixed with a little pyrites (or other sulphur compound) and sand, and fused in a reverberatory furnace, so as to slag off the iron and leave almost pure nickel sulphide, which is converted into oxide by calcination.

The oxide thus obtained is, if pure, intimately mixed with charcoal, and heated to whiteness in graphite crucibles, when it is converted into metal, and when molten is granulated by being poured into water. Some manufacturers, however, mixed the oxide either with finely-powdered wood charcoal, or with flour or starch made plastic with molasses, and mold the mixture into cubes, discs, or coarse grains, which are then packed in crucibles with charcoal and exposed to a heat short of that required for fusion.

The product of "cube nickel" thus obtained, though outwardly close-grained and coherent, is not strictly a homogeneous mass, but a loose sponge of metallic particles which retain all the impurities contained in the oxide plus from ½ to 2 per cent. of carbon.

The Canadian Copper Company, however, claim to produce a purer and more solid metal from which the carbon and silicon is entirely removed by melting the oxide direct. Its purity is shown by the presence of blow-holes on the surface, and a casting of 4,500 pounds weight exhibited at Chicago during the Exhibition assayed as follows:—Ni 98·78 per cent., Fe 0·301; S 0·068, Cu 0·76, Si 0·19, Carb. *nil*. It is usual in nickel casting to add a small quantity of magnesium or aluminium to produce a smooth surface.

The cost of smelting in Canada and the subsequent reduction of the oxide to metallic nickel by the method (*a*) first described, is stated to be as follows:—Breaking, 29 tons at \$0·30 = \$8·70; heap-roasting, 29 tons at \$0·50 = \$14·50; smelting for matte, 30 tons at \$2·50 = \$75; Bessemerizing, 5 tons at \$2 = \$10; first calcination, 2·50 tons at \$1·25 = \$3·15; chlorination and lixiviation, 2·50 tons at \$4 = \$10; second calcination, 1·75 tons at \$1·25 = \$2·19; second fusion, 1·75 tons at \$3·54 = \$6·20; pulverisation of refined sulphide, \$·50; first roast of sulphide, \$5; second pulverisation, \$0·50; second roast, \$5; total, \$140·74.

If the oxide is sufficiently pure to require no intermediate refining, and if it is reduced to granular metal by reduction in crucibles, the cost amounts to about eight cents per pound of metal produced, including in this crucibles, fuel, charcoal, labour, repairs, &c.

The cost of producing nickel from the Canadian pyrrhotite ore, therefore, works out as follows:—Mining and transport, 10 cents; conversion in oxide, 9 cents; reduction to metal, 8 cents; allowance for loss, 4 cents; total, 31 cents per pound.

The reactions which take place in the American process for extracting nickel from Canadian pyrrhotite, which has been described under this heading, are shown in Schedule C. (p. 641.)

(*b.*) Another method of dealing with Bessemerized mattes to convert it into nickel oxide is a new process invented by Messrs. M. Thompson and Charles Bartlett of the Orford Copper Company, who have been the largest refiners of nickel in the United States since 1891.

Having contracted some years ago to supply the Navy Department with nickel-oxide obtained from Sudbury matte, to be used in making nickel-steel, the first process tried was to dissolve out the nickel and iron sulphides from uncalcined matte with sulphuric acid, leaving the copper behind. The nickel and iron were then crystallized from the solution as sulphates, which were calcined, producing an oxide of nickel and iron quite free from copper. The objections to this method were the large plant required, its slowness, and the difficulty of obtaining a close extraction, as a considerable amount of nickel was left behind, and the matte got into such a condition that the operation could not be continued. Some cheaper and quicker method had therefore to be resorted to. Mr. Bartlett having observed that on melting the matte in a crucible with salt cake the metals tended to separate on either side of a distinct line of demarcation (the greater portion of the nickel being found in the bottoms and the greater portion of the iron and copper in the tops) led to the introduction of the present process. The great difficulty lay in obtaining a complete separation, but the various bars which at first seemed to stand in its way were at length removed, and the Company is able now to produce a nickel-oxide by this means, assaying—nickel 77·62 per cent copper 0·161, iron 0·637, silica 0·32, sulphur 0·025, and arsenic 0·047. The process in brief is as follows:—The metals in the matte are reduced by a preliminary melting, either in a Bessemer converter, or by ordinary calcining and melting in a blast furnace, till a point is reached when the metals are present substantially as sub-sulphides. This matte is then melted with analkaline sulphide (salt cake, *i.e.*, sulphate of soda) which in the blast furnace is reduced to sulphide of soda, and a reaction follows in which the copper and iron unite with the sulphur in the salt cake.

By adding a proper proportion of this reagent, the bulk of the iron and copper are converted into sulphides, and, mixing with the soda, make a very fluid mass, from which the subsulphide of nickel separates by gravity when cool, leaving the bulk of the copper, iron, and soda in the tops and most of the nickel in the bottoms.

On exposure to the weather, the soda in the tops is converted into caustic soda, and by mixing these tops with fresh matte and remelting them, the caustic soda is re-converted into sulphide of soda at the expense of the nickel, leaving the latter in a semi-metallic state; and again a top and bottom is formed, with copper and iron in the tops and nickel in the bottoms. By properly balancing these various treatments a pure sulphide of nickel is at last obtained, which, by calcining, is converted into oxide.

The production of nickel by the Orford Copper Company is given as follows:—

Year.	Receipts of Matte.		Receipts of Ore.		Fine Nickel in Oxide Produced		Fine Nickel in Oxide Furnished the U.S. Government.	
	Tons, 2,240.	Nickel Contents.	Tons, 2,240	Nickel Contents.				
	lbs.	lbs.	lbs.	lbs.	lbs.	value, dols.	lbs.	value, dols.
1891......	6,123	2,230,654	20	2,967	855,970	299,589·50	254,418	89,046·30
1892......	2,081	1,204,034	116	8,577	2,059,697	720,893·95	747,329	261,565·15

The following Table gives the estimated value and metal contents of Canadian matte produced in 1891; 6,278 tons being furnace matte, and 1880 tons being Bessemerized matte:—

	Tons.		Dollars.
Nickel	2,082	..	590,902
Copper	1,936	..	232,175
Cobalt	$8\frac{1}{2}$	..	3,713

Representing a total value of $826,750, the nickel being reckoned at $284 per ton, or 14·2 cents per lb., the copper at $120 per ton, or 6 cents per lb., and the cobalt at $437 per ton, or 21·84 cents per lb. f.o.b. the works, London quotations for the refined metal ruling at 42 cents per lb., and in New York at 48 to 52 cents.

The reactions which take place in the alkaline-sulphide process, employed for extracting nickel from Canadian matte, are shown in Schedule D (p. 642).

THE GOSSAN PROCESS.

Dr. S. H. Emmens has discovered that the nickel in pyrrhotite is rapidly dissolved by a solution of ferric sulphate, the re-agent which nature has employed in attacking the croppings of mineral veins, converting them into gossan. This reaction takes place gradually, even if the ore is in a raw state, but it is greatly accelerated by a preliminary low-roast. Dr. Emmens therefore proposes to replace the ordinary roast-heaps and smelters by weathering floors, a low roasting furnace, and lixiviation tanks, obtaining as a product either crystallised nickel sulphate or precipitated nickel, which is shipped to refiners. Dr. Emmens claims for this method simplicity, cheapness, and high concentration. The reactions taking place in the Gossan process for extracting nickel from Canadian pyrrhotite are shown in Schedule E (p. 644).

THE MACFARLANE PROCESS.

This is an application of the well-known Henderson method of treating calcined cupriferous pyrites, Mr. Macfarlane proposing to treat the nickeliferous pyrrhotite as follows :—(*a*) Roast in order to burn off the greater part of the sulphur ; (*b*) mix the roasted ore with about one-eighth of its weight of salt, and reduce the mixture to powder ; (*c*) calcine at a low red heat ; (*d*) lixiviate with hot water ; (*e*) add a small quantity of caustic soda to precipitate any iron present in the solution ; (*f*) add sodium sulphide to precipitate any copper ; (*g*) add caustic soda to precipitate the nickel as hydrate. The plant is to a large extent the same as used in the humid treatment of copper ores in Glasgow, St. Helens, and elsewhere.

I am indebted to the courtesy of Mr. Macfarlane for the complete specification of his process, which he forwarded with a letter to me, dated August 28th, 1894, and which reads as follows :—

"United States Patent Office.

"PROCESS OF EXTRACTING NICKEL FROM ORES.

"*Specification forming part of Letters Patent,* "*No.* 484,033, *dated October* 11*th*, 1892. *To* "*all whom it may concern :—*

"Be it known that I, Thomas Macfarlane, a subject of the Queen of Great Britain, residing in Ottawa, Canada, have invented certain improvements in the art of extracting nickel from ores, of which the following is a specification. This invention affords an improved means for extracting nickel from ores containing it, which is especially applicable for use with ores which are rich in sulphur. Nickel has heretofore been recovered from such ores by subjecting them to smelting processes; but my invention provides a means whereby the nickel in the ore is converted into a soluble nickel salt, which is dissolved out, and the metallic nickel recovered from the solution.

"In practising my invention, I take the ore commonly known as 'nickeliferous pryrrhotite' or 'magnetic pyrites,' in which from one to four per cent. of the iron, or about those quantities, are replaced by nickel, and after freeing it as much as possible from gangne, or rock, or silicious matter, I roast it either in heaps or kilns, or reverberatory furnaces in order to burn off the greater part of the sulphur, or utilise it for manufacturing sulphuric acid. I then take the roasted ore and mix it with about equal parts of unroasted ore and an amount of common salt (chloride of sodium) equal to about one-eighth of the ore employed, and reduce this mixture to powder by crushing and sifting it in mills and through sieves, or other apparatus suitable for the purpose. The resulting mixture should be fine enough to pass through a sieve having eight holes to the lineal inch. The raw ore can also be used unmixed with any previously roasted, and ground to powder along with the proportion of common salt above indicated. When residual proto or perchloride of iron can be obtained at a low price, it may be substituted for the sodium chloride. I then introduce the mixture into reverberatory, muffle, mechanical, or revolving furnaces and calcine it at a low red heat, with frequent stirring, until sulphurous gases are no longer given off, but in their place a strong odour of chlorine is evolved, when the charge is withdrawn from the furnace. During the calcination, samples may also be taken from time to time of the ore and tested by ascertaining, in the usual manner known to chemists, whether on leaching them out with water any proto-chloride of iron is contained in the solution. As soon as the solution shows itself to be comparatively free from proto-chloride of iron, the charge is withdrawn from the furnace. In this process the chlorine of the common salt is transferred to the nickel, and most of the chlorides of iron first formed are decomposed. Great care must be taken not to allow the charge to remain too long in the furnace, otherwise the chloride of nickel will be

decomposed into oxide. The acid vapours which are produced during this calcining or roasting process, may be withdrawn from the furnace, and carried through coke-tower condensers, such as are commonly used in chemical works, and the acid liquor thus obtained may be utilised for various purposes. I next take the calcined ore and dissolve out the chloride of nickel and other soluble substances contained in it with hot water, which operation is carried out in watertight wooden boxes or vats, furnished with a perforated false bottom, upon which is laid a filtering-bed of ashes, coke, or pine branches. The leaching is continued until no more nickel is removable, and the weak solutions are used for the treatment of charges of ore fresh from the furnace. The residual ore remaining in the vats may be used as an iron ore or for fettling in the manufacture of iron. I next take the solution obtained from the lixiviation of the calcined ore, and add to it a small quantity of a solution of caustic soda, sufficient to precipitate any peroxide of iron that may be present, a weak solution being employed for this purpose. To the filtrate from this precipitate a small quantity of a solution of sodium sulphide is added in order to precipitate, in advance of the nickel, any copper that may be present. The solution filtered from the copper sulphide is then treated with a solution of caustic soda of sufficient strength, which throws down all the nickel present as green hydrated oxide. This oxide is then washed, dried, and reduced to metallic nickel by any of the methods known to chemists. I prefer to make it up into a paste with the requisite quantity of wheat or other flour, roll out the paste, cut it into cubes, dry these, and expose them to a strong heat in plumbago crucibles.

"I claim as my invention the following defined features or improvements, substantially as hereinbefore specified, namely :—

"1. The process of extracting nickel from ores, consisting in calcining or roasting the ore with a chloride, dissolving out the resulting chloride of nickel, adding a weak alkali to the solution to decompose the perchloride of iron contained therein, and precipitate hydrated peroxide, and subsequently recovering the nickel from the decanted solution.

"2. The process of extracting nickel from ores, consisting in calcincing or roasting the ore with a chloride, dissolving out the resulting nickel salts, adding sodium sulphide to the solution to precipitate the copper therefrom, and subsequently recovering the nickel from the decanted solution.

"3. The process of extracting nickel from ores, consisting in calcining or roasting the ore with a chloride, dissolving out the resulting chloride of nickel, adding a weak alkali to the solution to precipitate out the peroxide of iron, then precipitating out the copper, then adding a strong alkali to precipitate oxide of nickel, and reducing this oxide to metallic nickel.

"4. The process of extracting nickel from ores rich in sulphur, consisting in first roasting the ore to expel the excess of sulphur, then mixing raw or and a chloride with the ore, calcining it, dissolvin out the nickel salt, and recovering the nickel fron the solution.

"5. The process of extracting nickel from ore rich in sulphur, consisting in first roasting the ore t expel the excess of sulphur, then mixing sodiur chloride with the ore, then calcining the mixture unti sulphur fumes cease to be given off and chlorin fumes appear, and until proto-chloride of iron i eliminated, then leaching the resulting ore first witl hot water to dissolve out the chloride of nickel adding weak alkali to the solution to precipitate per oxide of iron, adding sodium sulphide to precipitat copper, adding a strong alkali to precipitate oxide o nickel, and finally reducing this oxide to metalli nickel."

The Mond Process.

Mr. Ludwig Mond, F.R.S., has discovered that carbonic oxide (CO), if brought intc contact with finely-divided nickel at a temperature below 150° C., will form a readily volatilized compound, each molecule of which consists of one molecule of nickel and four molecules of carbonic oxide.

This "nickel carbon-oxide" (NiC_4O_4) is a colourless liquid, which boils at 43° C., and its vapour, when heated to about 180° C., becomes decomposed into metallic liquid and carbonic oxide. Mr. Mond therefore proposes to treat pyrrhotite by first pulverizing and dead roasting it to a condition of complete oxidation, then reducing it to a finely divided metallic state by subjecting it to the action of hydrogen or some other reducing gas at a temperature of from 350° to 400° C., then subjecting this finely-divided metal at a temperature of about 50° C. to the action of a current of carbonic oxide, which carries off the nickel in the form of vaporized NiC_4O_4, and leaves all other metals behind, and finally passing the vapour through tubes or vesiels heated to about 180° C., where the nickel separates out in coherent masses of great purity.

Dr. S. H. Emmens says that "if this process proves practicable on a large scale, it should supersede all others ; but some doubts may be permitted. In the first place it is known that iron also forms a volatile compound with carbonic oxide, and therefore the Mond nickel may contain too much iron to compete with the highly-purified market grades. In the second place, the finely-divided metallic powder soon becomes inert in the presence of carbonic oxide, and requires revivifying by being heated up to 300° or 400° C. in a current of carbonic oxide or hydrogen and

ooled down to ordinary temperature, by which ıeans its energy is restored. In the third lace the formation of NiC_4O_4 requires 24·34 ubic feet of Co for every pound of nickel aporized (= 1·51943 litres per gramme) and s in practice only a small portion of a flowing urrent of gas can be made to come into ontact with a powdered material, it follows hat each pound of nickel will require the flow f many times 24·34 cubic feet of CO "free rom oxygen or halogens." Mr. Mond, howver, and his colleague, Mr. Quincke, are not nen to be easily baffled by any difficulties of peration, and it is expected that the Mond ickel will soon enter the market.

The circumstances which led to the discovery f the process, and various chemical details onnected with it, will be found fully described n a paper read by Dr. Mond before the British Association, Section B, Cardiff, August, 1891, ntitled "Nickel-carbon Oxide and its applicaions in Arts and Manufactures."

The process depends upon the fact that ınder ordinary circumstances nickel alone is ıcted on when a mixture of this metal with any other metallic or mineral substance is treated y carbonic acid gas.

This discovery led Dr. Mond to institute xperiments with a view to ascertain whether t would not be possible to extract nickel lirect from its ores and such metallurgical products as nickel speiss and nickel matte. Experiments carried out under his instructions by Dr. Langer with a great variety of nickel ores from all parts of the world containing four to forty per cent. of nickel, as well as a number of samples of speiss and matte, are stated to have proved that as long as the nickel is not combined with arsenic or sulphur the process is entirely successful on a laboratory scale; in the majority of cases the nickel being entirely extracted in three or four days.

Such ores or matte or speiss have in the first instance to be calcined so as to convert the nickel completely into oxide. The mass is then reduced in a current of water-gas at a temperature of 450° C. It is cooled down to ordinary temperature and treated with carbonic oxide in a closed apparatus in which the ore is moved in an opposite direction to the current of gas, and in which fresh surfaces should be exposed to facilitate the operation. After a certain time the action of the gas upon the nickel becomes sluggish, and has tobe reheated again to 350°, which regenerates the activity of the nickel. This may be done in the same vessel, but it is preferable to employ a separate apparatus connected with the first, from which it is returned to the first vessel by means so that both vessels can be kept at the same temperature.

Schedules of Processes.

A.—*The European Process for Extracting Nickel from the Silicated Ore imported from New Caledonia.*

	Materials.	Reactions.	Products.
First Stage. —— Smelting for Matte.	1. The Ore. 2. Gypsum. 3. Ground coal. *Ground together and pressed into bricks.* 4. Fuel.	1. The silica unites with the magnesia and part of the iron of the ore and the line of the gypsum to form a slag. 2. The nickel and part of the iron of the ore unite with the sulphur of the gypsum to form a matte.	1. A slightly nickeliferous slag which goes to waste. 2. A highly nickeliferous matte which goes to the next stage.
Second Stage. —— Removal of Iron.	1. The matte from the first and fourth stages. 2. Sand. 3. Fuel.	1. Most of the iron and part of the nickel are oxidised by roasting. 2. The silica combines with the iron and nickel oxide to form a slag. 3. Most of the nickel retains its sulphur.	1. A slag which goes to the next stage. 2. Nickel sulphide which goes to the fifth stage.

Schedule A.—*Continued.*

THIRD STAGE. — RE-SMELTING FOR MATTE.	1. The slag from the second stage. 2. Sand. 3. Gypsum. *Ground together and pressed into bricks.* 4. Fuel.	1. The silica unites with the lime and part of the iron to form a slag. 2. The nickel and part of the iron unite with the sulphur to form a matte.	1. A slightly nickeliferou slag which goes t waste. 2. A nickel-iron matt which goes to the nex stage.
FOURTH STAGE. — REFINING THE SLAG-MATTE.	1. The matte from the third stage. 2. Sand. 3. Gypsum. 4. Fuel.	1. The silica unites with the lime and part of the iron to form a slag. 2. The nickel and part of the iron retain their sulphur.	1. A slightly nickeliferou slag which goes t waste. 2. A highly nickeliferou matte which goes t the second stage.
FIFTH STAGE. — REMOVAL OF SULPHUR.	1. The nickel sulphide from the second stage. 2. Nitrate of soda in small quantity. 3. Fuel.	1. The sulphur and nickel are both oxidised.	1. Gases which escape. 2. Nickel oxide whicl goes to the next stage
SIXTH STAGE. — PRODUCTION OF METALLIC NICKEL.*	1. The nickel oxide from the fifth stage. 2. Charcoal, flour, or other carbonaceous substance. 3. Fuel.	1. The oxide is made into a paste with flour, and baked. 2. The baked mass broken into fragments or moulded into cubes, disks, &c., and strongly heated parts with its carbon and oxygen, and becomes metallic.	1. Gases which escape. 2. Metallic "grain," "cube," or "disk" nickel which goes int the market.

* If the original ore contains arsenic, copper, cobalt, or manganese, these elements will also be found in the final metallic product, as the above depicted process is incapable of effectually removing them.

B.—*The Ordinary Wet Process for Extracting Nickel and Cobalt from Calcined Ores, Speiss, and Matte.*

	Materials.	Reactions.	Products.
FIRST STAGE. — SOLUTION.	1. The powdered ore, speiss, or matte. 2. Hydrochloric acid. 3. A jet of steam.	1. The acid dissolves out the soluble metals from the gangue and ferric oxide.	1. Gangue and ferric oxide which go to waste. 2. A mixed chloride solution which goes to the next stage.
SECOND STAGE. — REMOVAL OF IRON AND ARSENIC.	1. The solution from the first stage. 2. Chloride of lime. 3. Milk of lime. 4. A jet of steam.	1. Any arsenic and ferrous iron present are peroxidised and precipitated.	1. Ferric hydrate and iron arseniate which go to waste. 2. A mixed chloride solution which goes to the next stage.

Schedule B.—*Continued.*

THIRD STAGE. — REMOVAL OF COPPER.	1. The solution from the second stage. 2. Hydrochloric acid. 3. Sulphuretted hydrogen. 4. A jet of steam.	1. The copper is precipitated in the form of a sulphide.	1. Copper sulphide available for the production of metallic copper. 2. A solution of nickel and cobalt chlorides which goes to the next stage.
FOURTH STAGE. — REMOVAL OF COBALT.	1. The solution from the third stage. 2. Chloride of lime. 3. Milk of lime. 4. A jet of steam.	1. The excess of sulphuretted hydrogen is boiled off. 2. The excess of acid is neutralised. 3. The cobalt is peroxidised and precipitated.	1. Cobaltic oxide which goes into the market. 2. A solution of nickel chloride.
FIFTH STAGE. — PRODUCTION OF METALLIC NICKEL.*	1. The solution from the fourth stage. 2. Milk of lime. 3. Charcoal, flour, or other carbonaceous substance. 4. Fuel.	1. Nickel hydrate is precipitated. 2. The dried hydrate is made into a paste with flour, and baked. 3. The baked mass broken into fragments and strongly heated parts with its carbon and oxygen, and becomes metallic.	1. Gases which escape. 2. Metallic "grain" nickel which goes into the market.

C.—*The American Process for Extracting Nickel from the Canadian Pyrrhotite.*

	Materials.	Reactions.	Products.
FIRST STAGE. — HEAP-ROASTING.	1. The ore, in large fragments, built up into heaps. 2. Cord-wood.	1. Much of the sulphur is burnt off. 2. Much of the iron is oxydised.	1. Gases, which escape. 2. Partly desulphurised iron and oxydised ore, which goes to next stage.
SECOND STAGE. — SMELTING FOR MATTE.	1. The roasted ore from the first stage. 2. Nickeliferous slag from the second and third stage. 3. Coke.	1. The gangue of the ore unites with the iron oxide to form a slag. 2. The metals of the ore unite with the sulphur to form a matte.	1. A slag which goes to waste when it is not nickeliferous enough for re-smelting. 2. Nickel - cobalt - iron-copper - manganese matte which goes to the next stage.
THIRD STAGE. — BESSEMERISING.†	1. The matte from the second stage. 2. Silica. 3. A blast of air forced through the molten matte.	1. Some of the sulphur and much of the iron are oxidised. 2. The silica unites with the iron oxide.	1. A slag which goes to waste when it is not nickeliferous enough for re-smelting. 2. A complex matte low in iron and rich in nickel and copper.

* The nickel thus obtained is commercially pure.

† The refining of molten matte by a blast of air was first suggested by Gibb and Gelstharp (British "Provisional Protection," No. 874, of 1870), and was subsequently made practical by Pierre Manhes, of Lyons, France; but the process being generically similar to that of Bessemer's prior invention (in 1856), for the conversion of cast iron into steel, it is known by his name. It should, however, be added that W. Gossage, in 1856, proposed to treat "sulphurous ores" by currents of atmospheric air, which are forced up and through the melted mass.

C.—*American Process for Extracting Nickel from Canadian Pyrrhotite* (*continued*).

FOURTH STAGE. — REMOVAL OF COPPER.	1. The matte from the third stage. 2. Salt. 3. Fuel. 4. Water and a jet of steam.	1. The sulphur is oxidised to sulphuric acid, and combines with the sodium of the salt. 2. The chlorine of the salt combines with the copper. 3. The water dissolves out the copper chloride.	1. A solution containing the copper and some of the nickel, iron, cobalt, and manganese, which is then subjected to the ordinary "wet process." 2. A residue composed principally of nickel and iron oxides which goes to the next stage.
FIFTH STAGE. — REMOVAL OF IRON.	1. The oxides from the fourth stage. 2. Sand. 3. Sodium sulphide. 4. Charcoal. 5. Fuel.	1. The silica unites with the iron oxide and fluxes off. 2. The nickel and other metals unite with the sulphur.	1. A slightly nickeliferous slag which goes to waste. 2. A highly nickeliferous matte which goes to the next stage.
SIXTH STAGE. — REMOVAL OF SULPHUR.	1. The matte from the fifth stage. 2. Nitrate of soda in small quantity. 3. Fuel.	1. The sulphur and accompanying metals are all oxidised.	1. Gases which escape. 2. Metallic oxides.
SEVENTH STAGE. — PRODUCTION OF METALLIC NICKEL.*	1. The oxides from the sixth stage. 2. Charcoal. 3. Sand. 4. Soda ash. 5. Fuel and a stream of water.	1. The sand, soda, and part of the iron combine as a slag. 2. The oxides part with their oxygen to the carbon. 3. The molten metal when poured into the stream of water becomes "shotted."	1. Gases which escape. 2. A slag which goes to waste when it is not nickeliferous enough for re-smelting. 3. "Granulated" nickel which goes into the market.

D.—*The Alkaline Sulphide Process*† *for extracting Nickel from Canadian Matte.*

	Materials.	Reactions.	Products.
FIRST STAGE. — CONCENTRATION-SMELTING.	1. Matte. 2. Sulphate of soda. 3. Coke.	1. The sulphate of soda becomes reduced to sulphide. 2. Part of the iron and copper unite with the sodium sulphide.	1. "Tops," consisting of highly cupriferous and ferruginous matte, which goes to the next stage. 2. "Bottoms," consisting of highly nickeliferous matte, which goes to the third stage.

* The nickel produced by this method is not entirely free from copper and iron, and contains the greater part of the cobalt and arsenic originally present in the ore.

† This process was first suggested by C. Schafhaute, in 1839, followed by W. Jefferies in 1840, T. Bell in 1842 (with a discrimination between "tops" and "bottoms"), and W. Gosssge, in 1845 and 1850. It has recently been perfected by the officials of the Orford Copper Company at Constable's Hook, N.J., while preparing a supply of nickel oxide for use by the United States Government in the manufacture of nickel steel armour-plates. In this connection it may be mentioned that the use of nickel for improving cast iron was first suggested by M. Poole, in 1845, and that its addition to steel was first proposed by T. H. H. Kelk, in 1857.

D.—*The Alkaline Sulphide Process for Extracting Nickel from Canadian Matte (continued).*

SECOND STAGE. — "TOPS" SMELTING.	1. Weathered "tops" from the first and third stages. 2. Matte. 3. Coke.	1. The soda in the tops takes up some sulphur from the nickel in the matte, and forms a sulphide, which unites with part of the iron and copper.	1. "Tops," as in the first stage. 2. "Bottoms," as in the first stage.
THIRD STAGE. — "BOTTOMS" SMELTING.	1. "Bottoms" from the first and second stages. 2. Sulphate of soda. 3. Coke.	1. The sulphate of soda becomes reduced to sulphide. 2. Most of the iron and copper unite with the sodium sulphide.	1. "Tops," which go to the second stage. 2. Highly nickeliferous sulphide, which goes to the fourth stage.
FOURTH STAGE. — REMOVAL OF IRON.	1. Sulphide from the third stage. 2. Sand. 3. Fuel.	1. Most of the iron, and part of the nickel, are oxidised by roasting. 2. The silica combines with the oxides. 3. The nickel retains its sulphur.	1. A ferruginous and slightly nickeliferous slag, which goes to waste. 2. Nickel sulphide, which goes to the next stage.
FIFTH STAGE. — REMOVAL OF SULPHUR.	1. Nickel sulphide from the fourth stage. 2. Nitrate of soda in small quantity. 3. Fuel.	1. The sulphur and nickel are both oxidised.	1. Gases which escape. 2. Nickel oxide which either is sold in the market for steel-making or goes to the next stage.
SIXTH STAGE. — SMELTING FOR PIG-METAL.	1. Oxide from the fifth stage, moulded into bricks. 2. Charcoal. 3. Sand, soda, and lime. 4. Coke.	1. The sand, soda, and lime unite with the ash of the charcoal and coke. 2. The oxide is reduced to metal.	1. A slightly nickeliferous slag which goes to waste. 2. Pig-metal containing carbon and silicon.
SEVENTH STAGE. — REFINING.*	1. Pig-metal from sixth stage. 2. Silica, *i.e.*, an "acidic" lining in an open-hearth furnace. 3. Fuel.	1. Iron carbon and silicon are oxidised. 2. The iron and silica unite to form a slag.	1. Gases which escape. 2. A slightly nickeliferous slag which goes to waste. 3. Refined metal which is re-melted and granulated, and then goes into the market.

* Nickel prepared in the dry way from oxide obtained by the "alkaline sulphide" process, as applied to Canadian matte, is found to contain appreciable quantities of copper, iron, cobalt, arsenic, and other impurities.

E.—*The Gossan Process for extracting Nickel from Canadian Pyrrhotite.*

	Materials.	Reactions.	Products.
FIRST STAGE. — LOW ROASTING.	1. The Ore. 2. Fuel.	1. Part of the sulphur burns off, and part is converted into sulphuric acid, which combines with the metals present.	1. Gases which escape. 2. A residue (consisting of gangue, iron, oxide and metallic sulphates which goes to the next stage.
SECOND STAGE. — WEATHERING.	1. The residue from the first stage. 2. Air and moisture.	1. The ferrous sulphate becomes oxidised into ferric sulphate, which attacks the nickel, cobalt, and copper.	1. A mixture (consisting of gangue, iron, oxide and metallic sulphates) which goes to the next stage.
THIRD STAGE. — LIXIVIATION.	1. The mixture from the second stage. 2. Water. 3. A jet of steam.	1. The attack of the ferric sulphate upon the nickel, cobalt, and copper, is completed.	1. Gangue and ferric oxide and hydrate which go to waste. 2. Sulphates of nickel, cobalt, and copper, which are crystallised out from the solution, and go into market as a material to be refined by the ordinary wet process.

The CO can be employed dilute as it is obtained from gas producers, but as it is continuously recovered, a purer gas, such as can be cheaply prepared by passing carbonic acid through incandescent coke, is more advantageous, as its action is more energetic, and it admits of using a smaller vessel.

The gas charged with the nickel compounds is passed through tubes or chambers heated to about 200 C., in which nickel is deposited. The gas leaving these tubes is returned to the first apparatus, and circulates continuously. From time to time the nickel deposited is removed from the tubes, and to facilitate this operation thin nickel sheets, bent to fit the tubes, are inserted, on which the nickel deposits, and are easily taken out. The metal obtained is almost chemically pure, only rarely in the case of certain ores it is slightly contaminated with iron. Its density is equal to that of ordinary sheet nickel, and as the nickel is deposited in perfectly coherent films it is possible to produce articles of solid nickel, or goods plated with nickel, resembling in every way those obtained by galvanic deposition, reproducing with the same exactitude and fineness any design.

The difficulties in the way of the process, other than those alluded to by Dr. Emmens, are apparently of a mechanical nature, which are accentuated by the fact that the nickel compound is of a poisonous character, and has, therefore, to be confined in tightly closed vessels.

APPLICATIONS.—PURE NICKEL.

In its ordinary commercial form, nickel contains 98 or 99 per cent. of metal, consisting of a sponge-like mass of reduced and artificially agglomerated particles. In order to study its properties and to utilise it, it is necessary to melt it in a crucible to get rid of the occluded gases which cause its porosity, an operation requiring a high temperature and much care, because nickel, which is unattacked by atmospheric agents at ordinary temperatures,

xidises rapidly at a red heat, and its oxide issolved in a bath of metal renders the latter rittle. The operation is generally conducted 1 a crucible under a cover of flux, and the ietal is run into sand moulds, in which anodes)r electro-plating and various other kinds of rticles are cast.

When the nickel is to be rolled, in conseuence of a discovery made by Dr. Fleitmann, f Germany, a small quantity of some reducing, asily-oxidised metal, such as magnesium, ianganese, or aluminium, is added to the rucible a few minutes before casting, without vhich the metal is porous and irregular, and ias a yellowish grey fracture. Care should e taken to introduce this metal into the ottom of the crucible with a bar of pure iickel covered with fire-clay. It is probable hat, independently of their reducing action, xidisable metals, especially aluminium, act as purifying agent on the carbonic oxide disolved by the nickel in a similar manner to he action of aluminium in casting steel, improving the ductility and maleability of the netal to such an extent that it can be rolled nto thin sheets 3 feet in width. If used, however, in excess, both aluminium and manganese make the nickel very much harder. Pure iickel obtained in this way is easily forged, nd it possesses similar physical properties to hose of iron and copper. It is less malleable nd ductile than iron, and less malleable and nore ductile than copper. It alloys with both netals in any proportion.

It is slightly heavier than iron, with about he same specific gravity as copper. It melts it a temperature of about 2,900° Fahr. to 3,200° Fahr. A small per-centage of carbon in netallic nickel appreciably lowers its meltingpoint, making it almost as fusible as castron.

This metal is harder than either iron or copper. It possesses a greyish-white colour, takes a fine polish, and may be rolled easily or drawn into wire. It is unappreciably affected by atmospheric action or salt-water. The impurities it is most liable to contain are iron, copper, silica, sulphur, arsenic, carbon and in some cases a kernel of unreduced oxide. It is not difficult to cast if proper precautions are taken, but acts like some iron in being cold-short.

Its tenacity is intermediate between that of iron and steel, and, according to Deville, its point of rupture is 90 kilograms per square millimetre. The density of the pure metal is 8·38. Its electric conductivity is almost exactly that of iron. We know too that nickel is magnetic; according to Pullet it loses its magnetism at a temperature of 350°. It is magnetised under the same conditions as soft iron. Under the influence of feeble magnetising currents, it is magnetised five and a half times more than iron, but with magnetic currents of considerable strength, it is magnetised five times less.

The question of the temper of nickel has not yet been completely studied. At the works of Herren, Basee, and Sélve, Altona, three very pure commercial nickel bars, each weighing 30 kilos, and of the following composition* were cast:—

	Per cent.	Per cent.	Per cent.
Nickel	97·87	97·90	98·21
Cobalt	1·45	1·25	1·19
Iron	0·45	0·50	0·25
Copper	0·10	0·07	0·07
Silicon	0·19	..	..
Silicic acid	..	0·19	0·24
Carbon	trace	trace	trace
Sulphur	0·25	..	trace
Alkalies Ca and Al	..	trace	trace
Total	100·11	99·91	99·96

The moulds used were coated with chalk and uniformly heated to 130°. The crucibles were of ordinary graphite, lined with a thin layer of charnotte well burnt in. The furnaces were heated to a white heat with coke before introducing the crucible. The crucible during fusion was kept closed with a lid, and lifted out after the metal was properly fused to a watery-fluid mass, the temperature having at that time reached a blue heat. A small quantity of viscid green slag formed, which was removed with a graphite-paddle. The casting was done immediately after the drawing of the crucible. The cast nickel blocks were at once forged at the same temperature at which they were cast.

In all the baths 42 grains of magnesium were added per 30 kilos of nickel. Solid nickel is coming into use in Europe for a number of small articles which formerly were only nickelplated, thus one may see in the shops hundreds of small articles such as door-plates, oil cans, mounts for spirit-levels, tripod-heads for

* Oesterreichische Zeitscrift für Berg u. Hütten, und Salimenwesen, May 27th, 1893.

cameras, and the like. It is generally recognised that nickel-plating is not durable, and, as the price of the metal declines, we shall doubtless see a large increase in its consumption for such purposes as those named.

The writer some years ago bought a pair of nickel-plated skates, and has a vivid recollection of the rapidity with which they rusted directly the plating was scratched through, the corrosion being probably facilitated rather than otherwise by the galvanic action set up by the two dissimilar metals of which the skate-blade was made. Nickel steel, however, owing to its hardness and non-corrodibility, would probably be a far superior material f skate-irons than ordinary steel, and ought come largely into use for this purpose. Nick steel is also suitable for making steel pens ar other articles in which a non-corrodible meta effects a saving in cost.

Nickel is rolled hot as easily as iron. Ca bars are liable to be porous, but after hamme ing or rolling, are rendered compact an tough. A piece of pure nickel rolled plat (A), and an untreated cast bar of nickel (I were submitted to physical test by F. L. Sperr at the works of the Carbon Iron Company Pittsburg, Pa., with the following results :—

Cross section, inches.	Length between fillets, inches.	Ultimate strength per square inch in lbs.	Reduction of area. Per cent.	Ultimate elongation. Per cent.
A—3·11 by ·045	8	69,390	31·5	31·4
B—0·623	2	30,985	6·5	6·5

TEST OF STRENGTH OF MALLEABE NICKEL.

Material.	Tensile strength in lbs. per sq. in.	Elongation. Per cent.	Remarks.
Cast nickel	85,000	12	
Wrought nickel.............	96,000	14	Wrought, from 2 to 4 in. to ½ in. square
Wrought nickel, annealed	95,000	23	Wrought, from 2 to 4 in. to ½ in. square
Rolled nickel	78,000	10	Very hard, because not annealed afte rolling; rolled from 2 to ⅛ inch.

These figures are an average of a number of tests; as there were flaws in several of the specimens, the results are lower than they otherwise would have been. Nickel readily takes up carbon, according to Dr. Wedding ("Stahl u, Eisen, No 81893"), up to as much as nine per cent., which may exist either as amorphous or graphitic carbon. Its affinity for this element is strikingly shown in the Mond process of refining nickel. Nickel is forged, as before stated, and can be welded to itself or to iron. This latter property has given rise in Germany, Switzerland, and France, to the industry of nickel-plating by welding together two plates of given relative thickness, one of nickel and the other of soft iron (previously well scoured), by means of rolling them together. The two metals having similar coefficients of ductility, preserve during the rolling their proportional thickness in such a way that a plate of a tenth or a twentieth &c., may be obtained at will.

Steel and iron may be alike plated on one or both sides in this way, and in this condition is employed in place of pure nickel for a multitude of uses and domestic objects as this hot plating, or, more properly, welding, has not the defect of scaling off during use, as the electro-plated ware has; the union of the two metals being not merely a welding, but, in the nature of "cementation," an actual alloy being formed to some depth below the surface of contact. There is a steam-vessel in New York Harbour sheathed, as an experiment, in part

ith this material, which is fastened on with on nails. After eight months' constant ervice the iron nails have corroded away, and ll of the bottom, except the nickel sheathing, ; corroded and foul, whilst the latter remains s clean as when first put on. If nickel nails ere used, it is probable that nickel would nake an ideal sheathing for all salt-water raft. This material is also used for lagging team cylinders, feed-water heaters, &c. It ıkes a fine polish, and is stronger than brass r copper.

Nickel-plated wire, by virtue of the same rinciple, may also be manufactured and rawn out to any desired gauge. The same peration, whether for plating sheets or wires, an be effected with nickel-copper alloys. hese sheets, plated on one or both faces, ıke a fine polish, which is not affected by ıe air. They are employed largely in the ıanufacture of parabolic reflectors for lanterns ı place of silver, their cost being much less ıan those made of silver, and the polish they ıke being as brilliant, though of a darker hade. They are also more difficult to scratch. uch sheets admit also being stamped for the ıanufacture of cooking utensils, carriage are, lavatory and lamp fittings, &c.

Independently of plating, pure nickel in aves and threads is entering more and more to common use. As it is less malleable, and ss easy to melt or to mould than copper or rass, the appliances of the manufacturers ho manufacture the latter metals will not erve for nickel, and this has tended to delay ıe manufacture of nickel goods for domestic se. Nickel threads are employed very largely ı passementerie, Lyons being the centre of a pecial industry of gilded and silver laces lated on nickel, which do not tarnish through se, like those plated on white metal or brass. ure nickel is employed under the form of ıst or rolled anodes, in order to deposit on ıe surface of various objects, previously well coured, a thin layer of electrolytic nickel, hich takes a brilliant polish.

Becquerel was the first to make known a rocess of galvanic nickel-plating by means of neutral solution of the double sulphate of ckel and ammonia. The salt is still the base the baths at present employed, the exact omposition of which is subject to indefinite odifications. The important point is that e bath does not alter, and remains neutral ıring the whole operation, which is secured using anodes of pure nickel, which are dis-lved in proportion to the deposition of the nickel upon the objects to be nickelled. The process requires a very strong electrolytic current. A bath of 200 to 300 litres requires, for instance, six Bunsen elements of 22 centimetres; a dynamo is therefore usually employed.

The nickel bath usually consists of a solution of ammoniacal sulphate of nickel, of 7 or 8 per cent. strength, or say, 70 to 80 grammes dissolved in a litre of water. There is frequently added to this a mixture of phosphate and bi-carbonate of soda, with ammonia, with a view to increase the conductivity of the bath.

In place of anodes of nickel, insoluble positive anodes of carbon may be employed, in which case the bath must be fed with crystals of the ammoniacal sulphate of nickel. The foreign metals which would spoil the bath are precipitated by the daily addition of small quantities of sulphate of soda. The hot baths give the most brilliant precipitates, but less solid than those obfained from cold baths. When the object is removed from the bath it is dipped in hot water, dried in sawdust, placed in a cloth, and polished by the burnisher.

Messrs. Mond, Land, and Quincke, propose to apply nickel-carbon oxide obtained by the Mond process to nickel-plating, by dissolving this volatile substance in benzine or petroleum, or tar oils, this liquid being decomposed under the influence of a slight elevation of temperature, giving a brilliant deposit of nickel.

In order to cover objects with a coating of nickel they are immersed in the solution or in the heated vapour and subjected to heat, or they may be heated and the solution applied with a brush. If it is intended to obtain plates or casts of this metal by the electrolytic or other process, depositing surfaces are employed coated with graphite.

All the mattes produced by the Canadian Copper Company contain small amounts of silver, gold, and platinum, and in the electro refining of the Bessemer mattes comparatively large amounts of the precious metals are found in the slimes or residues deposited in the baths.

Spurrylite or arsenide of platinum is found in the surface sand of the Vermilion Mine, the property of the Canadian Copper Company. One from this mine has averaged 17·40 per cent. of copper, 16·80 per cent. of nickel, and contains 9 oz. of platinum per ton, whilst the yellow surface sand, a product of the decomposition of the underlying ore, has been found to contain 15·75 ozs. of platinum per ton.

Alloys of Nickel and other Metals.

Nickel will alloy with most of the useful metals, adding to their hardness toughness and ductility, and alloyed with copper and zinc, it makes the composition known as German silver, British plate, &c.; it alloys very readily with copper in all proportions, which influence the colour of the alloy. As its proportion reaches 6 or 7 per cent. the metal whitens; at 15 per cent., the alloy is distinctly white, and this proportion is only exceeded when it is necessary to obtain perfect whiteness, the maximum of effect being reached at 25 per cent. An alloy of this kind is susceptible of taking a beautiful polish, giving a clear reflection similar to silver. Air tarnishes this brilliancy, but with comparative slowness. Beyond 25 per cent. the increase in the proportion of nickel has no further effect on colour. The addition of a small quantity of cobalt gives an alloy of perfect whiteness, even when the proportion of nickel does not exceed 16 per cent. "Silverine" or "Argentan" has a composition based on this fact, The following is the formula of this latter alloy, patented by Mr. Pirsch:—

	No. 1.	No. 2.	No. 3.
Cu	79·50	75·00	71·00
Ni	16·00	16·00	16·50
Co	1·00	2·00	1·25
Zn	1·00	2·25	7·50
Su	1·00	2·75	2·50
Al	·50	·50	—
Fe	1·00	1·50	1·25

There is great confusion among the names and composition of binary, ternary, and multiple alloys of nickel, known under the general designation of white metals. Under the name "Maillichort," an alloy is made of nickel, copper, and zinc, containing a maximum of 15 per cent. of nickel; the remainder is composed of two parts of copper and one of zinc. "Silverine," "Argentan," "Packfong," &c., contain other metals as well, such as tin, bismuth, or antimony, which impart fusibility and a fine colour, generally at the expense of ductility. A certain quantity of iron is usually added if the nickel employed does not already contain it, in order to give hardness to the alloy, and zinc is introduced for the same object. The binary alloy of 90 per cent. and 10 per cent. of nickel is easily reduced to a galvanic powder, and sold for this purpose under various names. German silver, having a high specific resistance, is largely employed in electrical fixtures and appliances.

F. L. Sperry gives the following analyses nickel alloys:—

	Copper.	Nickel.	Zinc.	Iron.	Cobalt.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Berlin Alloys—					
Richest	52·00	22·00	26·00	—	—
Medium	59·00	11·00	30·00	—	—
Poorest	63·00	6·00	31·00	—	—
French Alloys—					
Table ware	50·00	18·70	31·30	—	—
"	50·00	20·00	30·00	—	—
Maillichort	65·40	16·80	13·40	3·40	—
Austrian Alloys—					
Table ware	50·00	25·00	25·00	—	—
"	55.60	22·20	22·20	—	—
"	60·00	20·00	20·00	—	—
Sheffield Alloys—					
Silver white	55·20	20·70	24·10	—	—
Electrum	51·60	25·80	22·60	—	—
Hard Alloy*	45·70	31·30	20·00	—	—
English	60·00	18·80	17·80	—	3·4
" elastic	57·00	15 00	25·00	—	3·0
Chinese packfong	40·40	31·60	25.40	2·60	—
American Alloys—					
Alloys for castings	52·50	17·70	28·80	—	—
" " bearings.	50·00	25·00	25·00	—	—
Bullet shells	75·50	24·10	—	0·40	—
One cent coin	88·00	12·00	—	—	—

* Can be worked cold.

		Per Cent
Vivian and Co., Swansea, Copper Nickel Alloy.	Si	·30
	Fe	·82
	Cu	48·49
	Ni	50·09
Société Le Nickel, Paris, Copper Nickel Alloy.	Si	·18
	S	·08
	Cu	48·74
	Ni	49·26
	Fe	·61
Wiggins and Co., Birmingham, Copper Nickel Alloy.	Si	1·3
	S	·04
	Cu	47·68
	Ni	49·87
	Fe	1·22

The preparation fusion, and especially the casting of these alloys, is an exceedingly delicate operation, demanding much skill to obtain regular ingots. Whatever the com-

›sition required, an alloy, "Christofle," is ›st made of copper and nickel, in equal pro- ›rtions, and a sufficient amount of the latter etal is afterwards added to produce the alloy ›sired, it being indispensable that the copper lded should be of the same quality as that in e 50 per cent. alloy, which is largely used r coachmakers' and saddlers' supplies, as ell as for surgical instruments. When the sion is complete, and the contents of the ucible at rest, it is stirred with a bar ıcased in fireclay, the surface skimmed, and ıe copper and other metals composing the lloy are added. A strip of green wood is also sed for stirring the molten metal, which is enerally cast in iron moulds coated with dry halk and uniformly heated to prevent the ıetal from cooling on the sides of the mould. Jnlike copper and nickel, the white metals re rolled cold. Maillichort requires several ›-heatings before it can be made into leaves. hese re-heatings require minute precautions, hich it would take too long to enumerate ere. The binary alloy, 20 per cent. of nickel › 80 per cent. of copper, prepared in suitable ›rms, may be rolled or stamped cold, with a mple annealing, without intermediate re-eating. This is of all the white metals the ne that has been most carefully studied, on ccount of its applications in the manufacture f ball-casings for the new arms of small alibre and great initial velocity. The adop- on of these arms necessitated the modifica- on of the projectile, which would be destroyed r, at least, distorted in the barrel of the veapon if made of hardened lead, as formerly. t was therefore necessary to cover the ball vith a rigid case made of a metal sufficiently ıalleable to conform to the rifling of the barrel, nd, on the other hand, capable of withstand- ıg the explosion without being put out of hape.

Lastly, it required an almost unoxidisable ıetal to secure the safe-keeping of the mmunition. These several conditions appear o be realized in the alloy of 20 to 80 per ent. adopted by most of the nations of Europe for their new armament, and it is stimated that the European demand for this ›urpose alone amounts to over 500 tons per nnum. An application indicated by the ›roperties of this alloy is its use for locomotive ire-boxes in place of copper. It is known hat the great difficulty in the manufacture of hese articles, apart from the large size of the ›lates to be rolled, which usually reach 3½ netres, is to procure uniformly good surfaces free from flaws, bubbles or other defects which, acting as centres of oxidisation, shorten the life of the fire-box. The relative slowness of oxidisation of the white metals gives them from this point of view great advantages, but such plates should be carefully examined and scraped with a graving tool during the rolling process, to remedy any faults which may reveal themselves. The manufacture of covers and silvered objects called "Roolz," "Alfenide" and "Christophile," from the names of the principal French houses which deal in this sort of ware constitutes an important outlet for nickel. The principle is well-known; viz., that of covering electrolytically a stamped or moulded article with a layer of silver of greater or less thickness. Formerly the metal upon which this deposit was made was brass, but its use has been rapidly abandoned and replaced by that of "maillechort," which has the advantage of not appearing yellow when use has removed the silver coating. In America polished dish-covers of white metal are largely used, replacing the old covers made of tin. Hundreds of tons of alloys are consumed annually in this way. The valley of Waterbury in Pennsylvania is the centre of this manufacture, favoured as it is by possessing magnificent water-power and a population accustomed to the working of nickel and white metals. This industrial centre is well-known for the manufacture of watch movements and cases of nickel or nickel-plate, which sell at a cheap rate all over the world.

At the present time some of the most promising uses for nickel are for the manufacture of body for electro-plating and white metal alloys; 25 to 28 per cent. of nickel added to a white metal alloy gives a material nearly as good as silver plate, which, besides being of uniform colour and quality throughout, can be kept elean with infinitely less trouble. A cheap electro-plated article will cost as much or more than a solid white metal one; and after the coating has worn it shows yellow, unsightly patches. Door fittings of white metal would cost, perhaps, 10 per cent more than brass, but would always be bright and clean, and be easily kept so. A gas bracket weighing 10 lb. made of white metal instead of brass would contain 2½ lbs. of nickel and 7½ lbs. of brass, the former costing $1·05 and the latter 75 cents, or $1·80 in all; there is, perhaps, $10 of labour on it, so that the increased cost through putting 25 per cent. of nickel into it would be only a fraction of the total cost, while a handsomer article would

result. Bath and lavatory fittings are now extensively made of white metal, and one manufacturer in England is said to turn out £200,000 worth annually. White metal is also displacing brass for lamps, chandeliers, electroliers, and railway carriage fittings. It is dearer but it tarnishes very little and a light rub will restore its planished appearance, where brass requires constant labour to keep it bright.

White metal has likewise taken the place of copper in a large number of countries in subsidiary coinage, in consequence of its smaller weight and superior wear, containing as a rule 25 per cent. of nickel and 75 per cent. of copper.

The following is a list of countries which have issued nickel money, and the date of the first issue of each:—United States of America, 1853, 1864, 1869, 1871, &c.; Switzerland, 1858, 1874, 1881, 1883, 1889; Belgium, 1861, 1862, 1863; Costa Rica, 1867; Peru, 1863, 1864; Honduras, 1869, 1870; Jamaica, 1871; Brazil, 1871; Chili, 1871; German Empire, 1874, 1876, 1888. United States of Columbia, 1874; Japan, 1875; Venezuela, 1876, 1886; Mexico, 1882; Servia, 1883; Equador, 1884; Bulgaria, 1887; Roumania, 1891; and Argentina Republic, 1891.

The issues are in general for ½d., 1d. and 2d. pieces. For 10 and 20 pfennings Switzerland and Germany have struck pieces of pure metal, which is more difficult to counterfeit and less subject to wear. They replaced pieces of 20 pfennings or under in silver which circulated with difficulty. In the United States the 5 cent. pieces are also of nickel, and it is said that the Austrian Government gave the French Nickel Company an order for 3,000,000 lbs. to be used for this purpose some two years ago.

Mr. F. L. Sperry speaking of nickel-steel says: "It will hardly be questioned that scientific research is directed most energetically at the present time upon the art of uniting elements in such proportions that they may be more serviceable than in their pure state. The limits of ultimate strength in the practical application of pure metals has about been reached."

The practical introduction of steel into general use has made a new era in manufactures, and steel is only modified iron, the difference in its state from a condition as soft as copper to one as hard as glass being due to the modifications of carbon. Up to recent times the distrust of steel was so great that marine and civil engineers were afraid to us it. In the early days of the Pennsylvania railroad its steel rails were imported from Eng land, bent to the curves of the road bed. A a superior metal for cutlery and tools it brough a fancy price of 36 cents. per lb. To-day ou battle ships are sheathed with thousands c tons of the best steel, and 800 tons are use yearly in the manufacture of steel pens.

Carbon steel was a great improvement ove iron, and the use of nickel in steel is found i all cases in which careful investigation ha been made to mark a further improvement i the manufacture of steel. A German authorit has recently observed that, considering th mutual affinity of nickel and iron as shown b the presence of nickel in meteoric iron, it i remarkable that the example of the handiwor of Nature has not been copied before this.

To quote Mr. W. H. Jacques, United State Ordnance Engineer, in a lecture delivere by him before the Franklin Institute o Philadelphia, January, 1892, Riley, Dick an Packer commenced their experiments wit samples of French crucible nickel-steel con taining 3 per cent. 5 and 25 of nickel; wer subsequently assured by personal investigatio that the desired products could be obtaine with certainty, not only in the crucible, but wit perfect control in the open-hearth, and tha nearly all the nickel would be found in the steel

Mr. Riley, in the lecture referred to (Iron an Steel Institute, May 4th, 1889), described th action of the steel in the mould, its appearance value of scrap, and the care and temperatur required to work it. He made a sufficien number of tests to show the marked increas of tensile strength and elastic limit produce by certain increments of nickel without impair ing the elongation or contraction of area t any noticeable extent. He pointed out th effects of a variation of the proportion o carbon and manganese with the same per centage of nickel, the point where the incre ment of nickel changed its hardening influenc to one of softening and ductilising, and it neutralising effect upon carbon, and th difficulties of machining.

Together with other conclusions, he said, "I am glad to be able to state that before th region of extreme difficulty of machining is reached, we have qualities of nickel stee available, which will be of the utmost value fo a very large number of purposes."

Comparing ordinary steel with nickel steel, he adds, "I think that there will be no hesitation in deciding that there will be

ery great gain by the use of the latter dvantage, either in the reduction of scantling r increased strength and ductility. In the ery important matter of corrodibility, it is vith the greatest satisfaction I can state that ne steels rich in nickel are practically non-orrodible, and that those poor in nickel are nuch better than other steels in this respect. ome samples of the richer nickel steels which iave been lying exposed to the atmosphere for everal weeks will show an untarnished fracure."

"These experiments to test the non-corrolible qualities of the various percentages of iickel steel, it will be remembered, were made n connection with Abel's corrosive liquid and iydrochloric acid water. It is thought that his non-corrodibility and other physical haracteristics, such as increased elasticity ind extraordinary elongation, will render iickel steel peculiarly well fitted for the nanufacture of heavy ordnance, especially for runs subjected to heavy pressure with nitro-powders. A test gun 304·5 inches long, veighing 31,300 lbs., made at the Washington Vorks, from forgings which contain 3·15 per ent. of nickel, was specified to possess the ollowing minimum physical requirements. For he tube, tensile strength, 85,000 lbs.; elastic imit, 42,000 lbs.; elongation, 20 per cent. For the jackets, tensile strength, 90,000 lbs.; elastic limit, 45,000 lbs.; elongation, 13 per ent. Nickel steel is also being tried for the arrels of the new small-bore rifles adopted by he United States Navy Department, and by educing the weight of such weapons may onfer a very appreciable advantage upon roops armed with nickel steel small-bores in he field.

Herr Krupp's comparative tests of two 3½-inch field-guns, one made of Krupp steel, and the other of nickel-steel, point to the nickel steel as likely to come largely into use for ordnance. Each gun was load with a shell containing 170 grammes of picric acid, he centre of the shell in each case being 30 centimetres from the muzzle. When the shells were exploded the crucible steel gun burst into many pieces, whilst the nickel steel gun remained entire, showing an increase of the bore of 7·4 m.m. at the site of the projectile, but no cracks anywhere. The trial was continued with another shell, containing 180 grammes of picric acid. Its explosion caused an enlargement of 9·50 m.m., and a longitudinal crack 80 m.m. long, but no particle of metal was detached from the gun.

A complete set of nickel steel forgings for an 8-inch gun has been made for the Bureau of Ordnance, United States Navy, and is now being assembled at the Washington Navy-yard. The average physical qualities obtained in these forgings in transverse specimens were :—

	Tensile Strain.	Elastic Limit.	Elongation.	Contraction of Area.
	lb. per sq. in.	lb. per sq. in.	Per cent.	Per cent.
Tube ...	93,200	58,300	21·2	42·0
Jacket..	99,900	60,000	20·4	45·9
Hoops..	109,100	68,200	20·5	46·9

Test specimens were 2 inches long by ½-inch diameter. Comparing with the average qualities usually obtained in corresponding navy-gun forgings made of simple steel, the tensile strength shows an increase of about 10 per cent., with an increase in elastic limit of from 22 to 28 per cent., while the contraction of area and elongation are but slightly reduced. The Bureau of Ordnance found, while experimenting, that two small-arm barrels showed greater endurance than others. They were respectively of a very high carbon steel ad a steel containing about 4½ per cent. of nickel. The latter was fairly easy to machine, while the high carbon steel was almost intractable; consequently, the bureau came to the decision previously mentioned, to adopt nickel steel for its small arm barrels. The great excellence attained by the Greener gun is attributed to the use of nickel steel barrels, containing 2·75 of nickel and 0·2 per cent. of carbon. It is to the manufacture and use of nickel steel to which the producers of nickel look for the chief increase in the demand for that metal.

Mr. Henry M. Howe points out that the resisting power of armour has been greatly increased by the adoption of nickel steel, and of the special processes of treatment which, like the Harvey process, probably mainly consist in very deep case-hardening or carbonisation.

A 10·5 inch Bethlehem Harveyised nickel steel plate, for example, broke up five Holtzer 8-inch armour-piercing shells, with a total energy of 25,040 foot-tons, and was itself but slightly cracked; and a Krupp 10·23 inch specially treated nickel steel plate destroyed three 5·9 inch and two 8·26 inch Krupp armour-piercing shells, with a total energy of 20,957 foot-tons.

The chief merit of nickel-steel, Mr. Howe

remarks, lies not in greater resistance to penetration, but in non-fissibility. It resists penetration admirably, but if struck with force enough, it lets the projectile through, but suffers relatively little harm itself beyond having a clean hole punched through it.

The report of the United States Navy Department for 1890 gives the results of experiments carried on at Annapolis, with a view to test the relative merits of the English compound plate*, the French all-steel plate, and nickel steel plate. The result of this trial showed that the compound plate was decidedly inferior, and that, as between nickel and all-steel, the former had distinct and positive advantages, the all-steel plate being broken into four pieces, and the nickel plate remaining absolutely uncracked.

A series of subsequent tests made the following year confirmed the conclusions formed at the Annapolis trial as to the superiority of nickel steel, and it was then decided to ascertain first whether American plates, or those manufactured abroad, showed any relative superiority, and, secondly, which of the various suggested methods of treatment gave the best results. The questions to be considered being the relative merits of rolling and forging, and the effect of Harveyising, a process designed to harden the surface of the plate, without reducing the toughness of its interior.

The results are stated to have proved that the nickel Harveyed plate and the American high carbon nickel plate were superior to any of the English or French plates.

Of the three Bethlehem plates, two were of nickel steel—one treated by the Harvey process, the other not—and the other was of all-steel Harveyised. Both the nickel plates proved far superior to the all-steel Harveyed plate, and both proved superior to the French all-steel plate, a Carnegie rolled nickel plate and a Bethlehem forged nickel plate both showing fully 10 per cent. more resistance to perforation than the French all-steel armour.† These trials seem also to have established the fact that armour of first-rate quality can be produced by the rolling process, the difference in penetration of 6-inch shots fired at rolled and hammered plates being inappreciable amount.

The importance of this fact can hardly be over-estimated, as if rolled plates could be substituted for forgings, it would mean a large reduction of cost, whilst the work could be thrown open to a number of firms who would not otherwise be able to bid for it, so that in all probability, within the space of a year or two, the armour-producing capacity of the American works could be quadrupled or more.

A test of a $10\frac{1}{2}$ inch nickel steel plate manufactured by the Bethlehem Company which had first been forged to $12\frac{1}{2}$ inches, then Harveyised, and finally re-forged to its proper dimensions, which took place at Indian Head on July 26th, 1892, showed a want of uniformity in the hardness of the surface and it became apparent that the right hand side of the plate had been softened in the process of re-forging, which resulted in a reduction of the carbonisation of the steel on one side of the piece.

A fresh trial was, therefore, made and on July 30th, 1892, a plate of nickel-steel was forged to its final thickness of $10\frac{1}{2}$, inches unlike its predecessor before being Harveyised, and gave eminently satisfactory results.

As in the previous trial, an 8-inch gun was alone used, and five Holtzer steel shells weighing 250 lb. each, with a striking velocity of 1,700 feet per second, and each with an energy of 5,000 tons to the square foot, were fired at the plate from a distance of 30 yards, subjecting the plate to five blows with a total energy of 25,000 foot tons.

All five projectiles were smashed on the surface of the plate, and the only injuries it sustained were the opening of a slight taper crack, four inches in length from one edge and a whale less than one inch in thickness on the back of the plate opposite each point of impact. The striking ends of the projectiles appear to have been splashed on the face of the plate, filling the slight indent made by the blow with a new material, which became welded to the substance of the plate itself and left it, as before, a flush surface. The remainder of the projectiles could only be found in the shape of innumerable scattered fragments.

As early as 1890, the Secretary of the Navy was so satisfied of the superiority of the nickel steel plate, that he asked and obtained from Congress an appropriation of $1,000,000 for the purchase of nickel-matte, and, fearing that a scarcity of supply might result from

* The type of armour plate used by the British Government has a hard steel face with a soft steel backing, and the Admiralty seem to have considered the question as to the best armour to use settled when they adopted this type in 1878. That it is settled satisfactorily, seems, however, far from being the case.

† The Bethlehem Iron Company forges all its plates, whilst Carnegie, Phipps, and Company employ rolls.

largely-increased demand and put up the rice, they purchased straight away from the anadian Copper Company 4,536 tons of atte, containing about 900 tons of nickel. he terms of the purchase specifying that the aterial was to be delivered free on board e cars at Sudbury, Ontario, commencing ithin three days from the signature of the ontract, and the order was to be executed in s entirety within one month, and that no ar-load was to contain less than an average f 15 per cent. of nickel.

Under this contract the Canadian Copper ompany received $321,321·86 for matte, hilst freight cost $31,134·88. The duty on he copper contents was $9,547·40 and re- ning by the Orford Copper Company cost, may be estimated, $97,582·30, making a otal expenditure under the appropriation of 459,586·44.

Forty per cent. of the nickel oxide produced y the Orford Company is used in America, while 60 per cent. finds a market in Europe.

According to the report of the American Naval Secretary for 1892, p. 21, after payment f all charges including price of the matte and ubsequent reduction, the cost of the nickel xide used by the United States amounts to 4 cents per lb., whilst it costs other consumers t least 38 cents. The quantity of armour late required by an ordinary American war essel, as at present built, is about 3,200 tons, nd, as only 3¼ per cent. of nickel is called for n the contracts with the makers, the quantity f nickel required for one vessel is only about 04 tons or say 135 tons of nickel oxide. An ccount of the trial of nickel-steel armour (the rst test of the kind made in England) which ook place on board the target vessel *Nettle*, n the 1st November, 1892, is given in "The Engineer," of November 4th, 1892.

This trial which was conducted by Captain H. Pearson of the *Excellent*, was introduced by Sir W. H. White, K.C.B., Director of Naval Construction, Admiral Colomb, General Geary, R.A., Captains Jenkins and McKechnie of the Ordnance Committee, Col. W. W. Barlow, and other officials. The Harvey Steel Company being represented by Messrs. E. W. Fox and J. H. Dickinson of New York, and the manufacturers Messrs. A. and T. Vickers of Sheffield being also present.

The plate measured 6 ft. × 8 ft. with a thickness of 10½ inches, and five rounds were fired at it with the 6-inch breech loader, charged with 48 lb. of E.X.E. powder, which discharged the five 100 lb. shells (3 Holtzer and 2 Palliser) at the target at a muzzle velocity of 1975 ft. per second.

"Iron," in its issue of November 4th, 1892, summarises this test as follows :—"The result of the firing was an astonishing success and completely verified the accuracy of the reports received from America with reference to the merits of the Harvey hardening process produced by cementation (carbonising of the face to a depth of several inches, and subsequently hardening it with jets of water). Contrary to ordinary experience the Palliser projectiles appeared to do as much execution as the French shells, for although they splashed upon the plate on impact, they made indents of about 1½ inches in depth. The Holtzers, on the other hand, appeared to weld their points into the target before bursting into a thousand incandescent fragments, every one was completely pulverised. The most remarkable feature of the trial, however, was the fact that the plate withstood its punishment so well that not a single crack was produced—a quite unprecedented circumstance in armour-plate experiments. Further trials with thinner plates are to be prosecuted at Portsmouth, and should these prove correspondingly invulnerable, many of our obsolete armour-clads might easily be brought up to date by superseding their thin iron protection by the new armour of equal thickness and weight, but of greatly superior impenetrability.

Comparing the relative depths of penetration in the Harveyised nickel steel, all-steel, compound, and soft steel armour plates, the ratio of superiority in favour of Harveyised nickel steel is given by Mr. T. L. Spurry as follows :—

Relative Penetration.	Kind of Armour Plate.	Relative Resistance.
1	Nickel steel Harveyized.	1
1·64	All Steel.	0·609
1·75	Compound.	0 572
2·2	Soft Steel.	0·455

"So that for equal powers of resistance there can be a saving of 43·8 per cent. in weight in favour of the Harveyised plate over the compound plate.* Krupp, of Essen, is furnishing, for vessels of the 'Brandenburg' class in the German Navy, nickel steel armour made on a new system. The plates are 5½ inches thick, and show a resistance equal to

* See "Stahl u. Eisen," No. 4. 1893.

plates of $9\frac{3}{4}$ inches made by the old system. The French Government uses an armour-plate containing 0·4 per cent. carbon, 1 per cent. chromium, and 2 per cent. nickel. Nickel furnishes toughness and chromium hardness. It is in the highly desirable qualities of extreme toughness and elasticity that nickel imparts valuable properties to steel, increasing its resistance to shocks and hindering crystallisation."

No exhaustive tests have, to the author's knowledge, yet been made in regard to nickel steel alloys in combination with chromium and manganese, and it appears to me that in alloys carrying varying per-centages of these elements, a wide field is offered for investigation of a useful nature, and it is by no means certain that we have yet arrived at the ultima thule of effective protective armour.

If, as I believe is the case, we are spending over £14,000,000 per annum to meet our naval requirements, and building battle-ships at a cost of £600,000 to £800,000 each for those of first rank, we cannot afford to use anything but the best of material, and, though nickel steel is more expensive than ordinary steel, it will make up for the extra cost, I believe, in greater lightness and increased efficiency, which, after all, are the chiefest, and, indeed, the points of most vital importance.

Referring to what nickel steel armour-plate costs the United States Government, the *Engineering News* of New York says:—"Bids were opened on February 5th at the Navy Department for about 7,000 tons of nickel steel armour-plate. The prices bid by the Carnegie and Bethlehem Works ranged from \$520 to \$885 per ton for different sizes and kinds of plates specified. About \$56 per to extra is asked for treating the plates by th Harvey process. It is of interest to note tha an average price of \$600 per ton, the armou for the new battle-ship *Massachusetts* will cos about \$1,225,000; the total cost of the vesse being estimated at \$3,020,000. The tota quantity of armour required in the constructio of this ship is 2,042 tons, the nickel content of which would be at $3\frac{1}{4}$ per cent.—not quit 150,000 pounds. Assuming the price to be 5 cents. per pound, the cost of the nickel content of the plate will not exceed \$75,000 (or \$46,75 at the cost of nickel oxide). Unless, then, th cost of making nickel steel is vastly greate than that of other alloys, the question of cos will not long stand in the way of its adoptio by Governments which are persuaded of it superiority. Nor is it likely that the Carnegi and Bethlehem Works will long continue t enjoy a monopoly of supplying this plate t the American Government at \$600 per ton."

The tests conducted by the Russian official at Ochta were made upon one French, tw English steel plates and a Vickers Harveyed nickel-steel plate, and in commenting upon this trial *The Engineer*, March 24th, 1893, reports the latter "to have altogether beaten its competitors." With all this evidence to show the value of nickel steel as an alloy for the construction of war vessels, the chances would appear strongly to favour its being used by the navy building powers. Yet the demand for the metal would not be enormously increased; if all navies were to be reconstructed with nickel steel armour-plate, it would not be necessary perhaps to more than double the present production.

Dimension of specimen.	Tensil strength.	Elastic limit.	Elongation.	Contraction.	Fracture.
Inches.	lb. per sq. in.	lb. per sq. in.	per cent.	per cent.	
0·496 × 2	94,185	58,995	26·4	60·83	Dense gray lipped.
0·497 × 2	94,245	60,770	25·55	60·58	"
....	93,215	58,740	25·8	61·33	"
....	93,730	60,770	25·8	59·81	"
0·498 × 2	92,410	59,550	28·0	60·74	"
....	90,350	56,470	28·0	60·74	"

Other Uses for Nickel.

Whence then is an increased demand for nickel likely to arise? What other purposes give greater promise of consumption than the making of armour-plate and ordnance? A few of these may be indicated. As an alloy of steel its greatest use may be found in engineering construction, where it is important to com-

ine lightness and strength. As for instance, ı marine-shafting, boiler-plates, car-wheels, inions and knuckles, shear-knives, bicycle pokes, gears for motors, and all classes of ork requiring hardness, toughness, and malleability.

Propeller Shafts.—For example, the proeller shaft of the United States Cruiser, *Brooklyn*, hollow forged, oil tempered, and ough machined, is made of nickel steel, and as an outside diameter of 17⅛ inches, an ıside diameter of 11 inches, and a length of 8 feet, 11¾ inches. This mass of metal veighs 19,112 lbs.

Test bars cut from this tube gave results as bove (p. 654).

The elastic limit of this shaft is about qual to the tensile strength of a shaft made f ordinary mild steel, while the elongation ınd contraction of area are nearly the same.

COMPARISON OF THREE STEEL SHAFTS.—CASE I.

	Propeller shaft U.S.S. *Brooklyn*. Hollow, outside diameter, 17 in.; inside diameter, 11 in.; nickel steel; E.L. 50,000 lbs. per sq. inch.	Solid shaft, same sec. area (approximately). Diameter, 13 in.; ordinary steel; E.L. 30,000 lbs. per sq. inch.	Solid shaft, same strength under applied loads or H.P. Diameter, 18·9 in.; ordinary steel; E.L. 30,000 lbs. per sq. inch.
Area of sec. sq. in.	131·95	132·73	280·55
Weight per yd. lbs.	1,346	1,354	2,861
Composite strength under applied loads in flexure or under applied H.P. in torsion	307	100	307
Load in lbs. at middle of a span of 12 ft. on two supports which strains to one-half elastic limit.	276,200	89,900	276,200
Length of beam on two supports which is strained by its own weight to one-half elastic limits	121 ft. 6 in.	77 ft. 6 in.	83 ft. 4 in.
Horse-power transmitted at 50 revolutions per minute when strained to one-half elastic limit.	15,780	6,130	15,780

The annexed Tables give the results of calculations made by Prof. Mansfield Merriman, of Lehigh University, Pa, and indicates the strength of the nickel steel shafts of the Brooklyn and Iowa, within their elastic limits, compared with that of solid steel shaft of the same sectional area made of ordinary soft steel, having an elastic limit of 30,000 lbs. per square inch, and compares the relative weight of nickel steel shafting per yard with that of solid soft steel of equal strength.

CASE II.

	Intermediate line-shaft U.S.S. *Iowa*. Hollow, outside diameter, 15¾ in.; inside diameter, 9¾ in.; nickel steel; E.L. 50,000 lb. per sq. inch.	Solid shaft, same sec. area (approximately). Diameter, 12⅜ in. ordinary steel; E.L. 30,000 lb. per sq. in.	Solid shaft of same strength under applied loads or H.P. Diameter, 17·71 in., ordinary steel; E.L. 30,000 lb. per sq. in.
Area of sec. sq. in.	120·17	120·28	246·34
Weight per yd. lbs.	1,225	1,227	2,513
Composite strength under applied loads in flexure, or under applied H.P. in torsion	293	100	293
Loads in lbs. at middle of a span of 12 ft. on two supports, which strains to one-half elastic limit	227,200	77,500	227,200
Length of beam on two supports which is strained by its own weight to one-half E.L.	115 ft. 6 in.	75 ft. 9 in.	80 ft. 8 in.
Horse-power transmitted at 50 revolutions per minute, strained to one-half elastic limit	12,980	4,430	12,980

The hole in a hollow-forged ordinary steel shaft of 15½ inches outside diameter is 7 inches. Nickel-steel hollow-forged shafts having the same outside diameter may have a hole 11¾ inches diameter, but for fear of any possible chance of "buckling" the hole is made 9¾ inches diameter. The propeller shafts of the American line steamers *St. Louis* and *St. Paul* are of nickel steel. They will stand 42½ tons

breaking strain per square inch, and show 28 per cent. elongation, and 50 per cent. reduction of area per square inch.

The shaft of the *Iowa* will stand 45 tons breaking strain per square inch while $33\frac{1}{2}$ tons is the limit in ordinary steel shafts.

Here, then, is a material admirably suited to the shafting and engine forgings required by the marine engineer of modern high-service engines, and it is believed that, as its merits become known its use will be widely extended. In the highest development of modern marine engines reduction of weight of all parts is of prime importance. This can only be accomplished by reducing sectional area. On the other hand outside dimensions cannot be usually reduced without sacrificing necessary stiffness. We are therefore led to removing the metal along neutral axes, or in other words, to the use of hollow forging. It is evident that to further reduce weight as well as to increase the absolute strength of parts the designer of marine engines needs a stronger material than that now employed; that is, a material having a greater elastic limit, but at the same time possessing such a degree of toughness as to insure resistance to sudden strain and shock.

Ordinary steel strengthened and toughened by tempering and annealing will show in specimens cut from the centre of sections, say 3 to 6 inches thick, an elastic limit of about 4,500 lb. per square inch, an elongation of about 23 per cent., and a contraction area of 50 to 55 per cent. A further and very pronounced improvement in strength and toughness can be obtained by the use of nickel-steel tempered and annealed as above described. The use of nickel allows a reduction of carbon, makes the steel more sensitive to temper, and facilitates the tempering of irregular shapes. Specimens from nickel-steel forgings tempered and annealed will show uniformly an elastic limit of from 50,000 to 55,000 lb. per square inch, an elongation of 23 per cent. and above, in specimens 2 ins. long by $\frac{1}{2}$ in. diam., a contraction of area of from 55 to 60 per cent. In cases where, owing to thickness of section and irregular shape, tempering is not advisable, nickel-steel will show a higher combination of elasticity and toughness than any other material known under same conditions.*

In a large Atlantic liner the plates of the boilers are $1\frac{1}{2}$ inches thick, and enormous force is required to bend and rivet them, in which operation the plate is likely to be weakened by fracture, the lines of which are not always visible. If made of nickel-steel alloy the plate would require to be little more than half the thickness, and while the boiler would be more easily and securely made, it would be but one half the weight—a very important item when there are twelve or thirteen huge boilers in the hold of one ship. Its strength would be as great and it would be less liable to corrode. It would cost a little more, but its life would be lengthened.

Mons. Garnier gives the results of a number of tests made in September, 1892, at the Cleveland Rolling Mill Company's Works, to determine the relative quality of steel with and without the addition of nickel.

The two steels differed only in the amount of nickel added to them, the quantity being about 3 per cent. The method of manufacture and the charges of both heats were absolutely identical. The ingots for both heats were rolled into boiler-plates under ordinary conditions. The tests showed the following results —(1) Nickel steel has, on an average, a higher limit of elasticity of about 11,400 lbs per square inch, or nearly 31 per cent; (2) nickel steel has an ultimate tensile strength greater by 10,400 lbs. per square inch, or an increase of about 20 per cent.; (3) the ductility is not reduced by the presence of nickel. The nickel used was made from Sudbury ores, at the Brooklyn Nickel Works near Cleveland.

In the making of parts of locomotives and steam-engines, as well as in the manufacture of cranks and shafting, nickel steel appears also to have decided advantages over all-steel. A locomotive is worth perhaps \$100 per ton, and where the cost is so much largely made up of wages for labour, as it is in this case, a small addition to the cost of raw material is of little consequence. Many parts of locomotives, such as axles, tyres, framework, &c., could be made of not much more than half the present weight, and just as strong, saving dead weight. It is reported that locomotive tyres are being made out of nickel steel in Germany, and are displacing tyres of English make.

Flange Steel.

Mr. Sperry (p. 12 to 13 of paper quoted) gives details of some interesting experiments upon flange steel, made with and without nickel, by the Cleveland Rolling Mill, which showed an average increase in

* R. W. Davenport, Vice-President, Bethlehem Iron Company, "Trans. Naval and Marine Engineers." Vol. I. 1893.

astic limit, with the nickel steel of 11,400 lbs. er square inch, or about 31 per cent; and an verage increase of 10,400 lbs. per square ch, or about 20 per cent. in ultimate rength, without any perceptible effect upon s ductility, as evidenced by the per-centage elongation and contraction of area. He lso gives a Table (p. 14) showing the effect of xperiments made upon nickel steel in an nprovised acid—bottom open—hearth furace, with varying per-centages of nickel and rbon, made at the Canadian Copper Comany's Works.

The specifications of the Baltimore and hio Railroad for steel tyres, and the United tates Navigation Bureau of Steam-engineerng for crank and propeller shafts, connecting nd piston-rods, and ordnance, are as ollows:—

Specifications of Baltimore and Ohio Railway.

	Carbon.	Tensile Strength.	Elongation in 4 inches.
	Per cent.	lbs. per sq. in.	Per cent.
rade I. ...	0·50 to 0·60	105,000	—
,, II. ...	0·60 to 0·70	115,000	
,, III. ...	0·68 to 0·78	125,000	

Grade I. is for passenger-engine tyres, outide diameter 60 inches; Grade II., for Conolidation Mogul, &c., outward diameter 45 to 0 inches; Grade III., for switching-engines, ar-wheels, and all tyres less than 46 inches in utside diameter. A variation of 10,000 lbs. n tensile strength above or below the above igures is permitted.

pecification of the Bureau of Steam Engineering, United States Navey.

	Tensile Strength.	Elongation in 2 inches.	Contraction of Area.
	lbs. per sq. in.	Per cent.	Per cent.
ropeller shafts....	85,000	23	..
rank shafts	58,000	28	..
onnecting rods ..	65,000	25	..
iston rods........	65,000	25	..
rdnance	85,000	18	35

Soft or low carbon steel certainly possesses dvantages over hard or high carbon steel, as t is easier to machine and, what is of greater mportance, may be subjected to much rougher treatment, because it is not subject to the dangerous internal strains of hard steel.

It is in this respect especially that nickel steel, having the superior qualities of soft steel, fulfils the requirements of service sought for in hard steel, and offers to engineers the advantage of a material which will give greater strength with the same weight, or equal strength with less weight, than any other at their disposal.

The following Table is given by Mr. Sperry in order to compare the accepted standard of mild steel with nickel steel having approximately the same carbon contents:—

	Tensile Strength.	Elongation.	Contraction of Area.
	lbs. per sq. in.	Per cent.	Per cent.
Ordinary Steel	65,000	23 in 8 inches	48·0
No. 13 Nickel Steel (2·05 per cent. nickel)	84,650	31·5 in 2 inches	55·4
No. 14 Nickel Steel (3·35 per cent. nickel)	100,650	27·0 in 2 inches	48·1

It is generally found that better results are obtained by using more rather than less than 3 per cent. of nickel, as the tensile strength and elastic limit is increased thereby up to the point of extreme hardness in machine, which is determined by the per-centage of carbon.

Torsion tests made upon specimens of nickel steel 1¼ inches square showed the following results:—

Number of Specimen.	Carbon.	Nickel.	Torsion breaking point in lbs.	Degrees of twist in 3 inches before breaking 360 degrees full twist.	
	Per cent.	Per cent.	Per sq. in.		
14	0·16	3·35	2,325	360	—
19	0·19	2·62	2,150	130	Split
13	0·22	2·05	2,434	240	Twisted off
15	0·31	3·40	1,807	355	—
41	0·51	4·93	2,200	120	—
24	0·54	3·00	1,200	60	Split
29	0·96	3·10	1,700	60	Split

In a cold bending test at the laboratory of Lehigh University of a specimen 2½ by 2½ inches (full thickness of wall of forging) 18 inches long, under hydraulic press, through 180°, the ends met within ½ inch; the greatest distance between sides was ⅞ths inch. There was only one slight crack in one corner on the inside of the bend.

The per-centage of nickel in all United States Government work of the kind here mentioned is 3·25 per cent., with carbon at about 0·2 per cent.; but familiarity with working and cheapening in cost of manufacture may probably admit of the per-centage of nickel being increased above this figure with advantage. Resistance to cracking (non-fissibility) is shown more remarkably as the per-centage of nickel increases.

Bars of 27 per cent. nickel shown in the Columbian exhibit of the Bethlehem Iron Company, markedly illustrate this property. A 1¼ inch square bar was nicked ¼ inch deep, and bent double on itself without further fracture than the splintering off of the nicked portion. With this per-centage of nickel the steel is practically non-corrodible and non-magnetic. For such purposes as shafts, axles, &c., where failure is the result of the fatigue of the met the higher elastic limit of nickel-steel w tend to prolong the life of the piece, a through its superior toughness offer great resistance to sudden strains produced shock. In lines of shafting, its increas stiffness will materially assist in maintaini true alignment; greater homogenousness also claimed for nickel-steel owing to t tendency nickel is said to have in checki segregation, a fact upon which Mr. Pourc laid stress in his paper on "Segregation, read before the Columbian Engineering Co gress—a matter of vital importance whe great uniformity of material is required, esp cially in pieces of large dimensions.

In America the nickel is generally charge into the furnace in sheet iron boxes, in th form of oxide. In other countries pig or ferr nickel is used. Some steel plants use metalli nickel, which possesses the advantage th less nickel slags off. The best results ar obtained in the basic open-hearth furnace.

The following tests made on nickel-steel together with the report of the Bethleher Iron Company by Mr. Maunsel White, cor roborate the claims made for nickel-steel:—

TESTS OF NICKEL STEEL.

Composition.	Specimen from	Dimensions of specimen.		Test per sq. in.		Per cent. exp.	Per cent. cont.	Remarks.	
		Size.	Length.	Tensile strength.	Elastic limit.				
3¼ per cent. nickel steel.	Forged bars	625	4	276,800	..	2·75	..	Special treatment.	Forged from 6 in.
		,,	,,	246,595	..	4·25	6·0		ingot to ⅝ in
		,,	,,	105,300	..	19·25	55·0	Annealed.	diameter, with
	1¼ inch round rolled bar	564	4	142,800	74,000	13·0	28·2		heads for hold-
		,,	,,	143,200	74,000	12·32	27·6		ing, showing
		,,	,,	117,600	64,000	17·00	46·0		the effect of
		,,	,,	119,200	65,000	16·66	42·1		varying carbon.
		,,	,,	91,600	51,000	22·25	53·2		
		,,	,,	91,200	51,000	21·62	53·4		
		,,	,,	85,200	53,000	21·82	49·5		
		,,	,,	86,000	48,000	21·25	47·4		
27 per cent. nickel steel.	1¼ inch square bar, rolled ..	798	8	115,464	51,820	36·25	66·23		Rolled down from
		,,	,,	112,600	60,000	37·87	62·82		1 in. ingot to 1½
		,,	,,	102,000	39,180	41·37	69·59	Annealed.	in. sq. billet, and
		,,	,,	102,510	40,200	44·00	68·34		turned to size.
	1 inch round bar, rolled........	500	2	114,590	56,020	47·25	68·4		Rolled down from
		,,	,,	115,610	59,080	45·25	62·3		14 in. ingot to 1
		,,	,,	105,240	45,170	49 65	72·8	Annealed.	in. round, and
		,,	,,	106,780	45,170	55·50	63·6	,,	turned to size.

Nickel-Steel Wire.

Steel containing 30 per cent. of nickel can ᵉ drawn into wire as easily as ordinary steel. /ire of this class contains enough nickel to e practically non-corrosive, and is specially lapted, in consequence, for hawsers and ıbles exposed to the action of salt water. A ımple of nickel-steel wire containing 27·8 per ᵉnt. nickel and 0·40 per cent. carbon, used as ırpedo-defence netting by the United States avy, gives the following physical test :—

Diameter of cross-section..	0·116 inch.
Area of cross-section	0·01057 sq. in.
Reduced diameter	0·106 inch.
Reduced area	0·0088 sq. in.
Contraction area	16·5 per cent.
Elongation in 2 inch.	6·25 per cent.
Load	2,100 lbs.
Breaking strain per sq. in..	198,700 lbs.

'he high tensile strength of this wire, with the omparatively small reduction in elongation nd contraction of area, indicates extreme ›ughness, and, at the same time, it is not cted on by salt water, so that it admirably nswers the requirement of marine service.

The Niagara Falls Power Company has ecently installed four 5,000 horse - power lectric generators, coupled to water turbines. n this type of generator the periphery of the arge rotating field travels at the rate of nearly wo miles per minute. The bobbins are secured ithin a ring of nickel steel, that is, forged ithout a weld, having an outside diameter of 39⅝ inches; inside diameter, 130 inches; idth, 50¾ inches; weight, 28,840 lbs. This ing of nickel steel is extremely light for its trength, and resists the centrifugal forces of his large field while adding but little to its eight.

Demand and Supply.

No little misapprehension seems to prevail s to the demand for nickel, and there are ome people who think that there is no limit ɔ the quantity the market is able to take. 'ourteen years ago the French Nickel Com-any refined 300 tons a year; two years ago hey were refining 4,000 tons.

The production and price of nickel is sum-narised by Mr. Sperry, as follows :—The otal production of the world from 1840 to 860 was about 100 to 250 tons per annum of ıetallic nickel; from 1860 to 1870, 600 to 700 ons yearly; from 1870 to 1889 about 1,500 ons; in 1890, 2,000 tons, and a fair estimate ɔr 1894 is about 5,000 tons, of which Canada ›roduced about one-third, and New Caledonia two-thirds. The metal sold for $2·25 per lb. in 1860, in 1873 to 1875 for $6 to $7 per lb. From that time the price gradually declined, being $0·65 per lb. in 1892, and less than $0·40 at present. The exceedingly high prices in 1873 to 1875 were caused by the adoption of nickel coinage by Germany and other European countries. Nearness to market, better climate, abundance of ore, and a supply of competent free labour, facilities for rapid transport, are advantages which Canada possesses over New Caledonia; on the other hand, the New Caledonia ores are richer and easier to treat, but the ore is found in V-shaped pockets in the serpentine, which are liable to pinch out suddenly, a circumstance which adds to the cost of mining.

In 1892, the world's production of nickel had reached 6,000 tons. It will not be very surprising, should improvements continue to be made in processes of treatment, if within the next decade prices should have fallen to 25 cents or even 15 cents per lb., and in such an event a large increase may be expected to take place in its consumption.

According to Mr. Ian Cameron, manager of the Dominion Mineral Company's Works, the break in price which took place some twelve years ago, when nickel fell from 2s. 6d. to 2s. per lb., led to such an increase in demand that it exceeded the supply. Mr. Cameron adds, "When I built the old smelting works for the French Company, at Kirkintilloch, in Scotland, I completed one furnace, and was then instructed to put up another two. I actually erected five, and with twelve the company could not, until the slackness a few months ago, overtake the work. The furnaces are small, and together they rnn about 4,500 tons per month. The ore is peculiar; it contains about 8 per cent. of nickel, and does not lend itself to treatment in large quantity. If it could be as easily fluxed as the Sudbury ore the furnaces could run through an enormous quantity. I think the supply of nickel is greater than the demand, and that this is the reason there is no greater expansion of the industry in this country or in New Caledonia. The demand is not by any means unlimited; we have got to make our trade as we go along.

One trouble in Canada is the dearness of the labour, which costs as much as 50 per cent. of our whole expenditure.

The duties upon the stuff we buy also runs up to a high per-centage; for example, the duty on coke amounts to 8 or 10 cents per ton of ore. The net value of 3½ per cent. ore, after

paying all costs at present selling price, cannot be more than 1s. per ton, the royalty on which, at 3 per cent., would be 3 cents per ton. The duty on coke therefore is three times as much as all that would be paid to the Government for royalty.

I do not know that it would be a great advantage to have the refining of nickel done in this country (Canada). According to present practice acids are required, and these cannot be bought as cheaply here as on the other side of the Atlantic, and there are other things we should have to import.

Another disadvantage is that freight charges on refined nickel going to Europe would be greater than on matte. The rate on 100 tons of matte containing 50 per cent. of nickel, would be $6 or $7 per ton, but owing to risk of carriage 50 tons of refined nickel would not be carried at $12 per ton. I do not think there is much hope of refining nickel in this country until the consumption here has greatly increased, or until chemicals and other necessaries in refining can be bought as cheaply as in England or France, or until a successful dry process has been introduced. We could not refine here according to present practices and under existing conditions, and hope to sell the nickel in Europe, and as there is a heavy duty on the fine metal in France and Germany as well as in the United States it would not pay do so.

Remembering that it is a comparatively new metal, and that until a few years ago its ore was scarce and hard to treat, the rank to which the nickel industry has attained m well excite wonder.

The progress of operations in Ontario view of the circumstances, and especially the fact that the largest refining concern the world is also chief owner of the o mining properties which can compare in ric ness and extent with those at Ontario, h certainly been as active as the market for t metal would seem to justify.

Mining and smelting was started less th nine years ago, yet, measured by the numb of men employed (440 mining and 690 in t reduction works in 1892), the amount of wag paid for labour, and the value of the produ there are only six iron-working industries the province as shown by the census of 18 which exceed this one, and amongst the are such old and stable industries as agric tural implements, blacksmithing and found and machine shops. Of iron mines there not one worked, though iron ores occur great abundance. Neither is there one bla furnace to smelt iron ore, although upwar of 300,000 tons of pig-iron are consumed the province annually. All the indicatio point to a steady increase in the consumpti of nickel, and the number of new and usef uses that are being found for it give assuran that the industry is firmly rooted and w grow.

The relative production of nickel by vario countries is shown by the accompanyin Table:—

THE WORLD'S PRODUCTION OF NICKEL* (IN KILOGRAMS).

Year.	New Caledonia.	Canada.	United States.	Norway.	Sweden.	Total.
1889	1,381,482	309,701	98,731	88,500	—	1,878,414
1890	1,633,214	651,239	90,870	70,500	8,050	2,454,873
1891	2,449,306	2,098,598	54,815	91,000	12,000	4,705,719
1892	†2,800,000	1,888,790	43,614	†90,000	—	4,822,404
1893	†2,800,000	1,811,205	11,745	†90,000	—	4,712,950

* "The Mineral Industry," 1893, p. 476. † Estimated.

CONCLUSION.

It is impossible for the author to individually acknowledge all the various sources to which he is indebted for information; he must, however, express his acknowledgements in particular—

1. To Dr. S. H. Emmens for much private information which he has generously afforde in addition to that derived from his vario published papers.

2. To the official reports of the Ontar Bureau of Mines.

3. To the sections devoted to nickel in t "Mineral Industry," vols. I. and II., whi

ive much valuable statistical and other infor- ιation.

4. To various articles in the "New York [ining Journal."

5. To information published by that distin- uished authority upon nickel, Mons. Levat.

6. To a paper by Mr. L. Sperry on "Nickel teel," read this year before the American nstitute of Mining Engineers.

DISCUSSION.

Mr. R. MOND said there was one point Mr. harleton had not mentioned. It was the electrolytic rocess for obtaining nickel from nickel-copper ıatte, a modification of a well-known method. The ickel matte was treated with cupric chloride, which aused the copper and nickel to go into solution, nd the iron also. Thus you obtained a solution ontaining nickel chloride, ferrous chloride, and upric chloride. The iron was precipitated by any rdinary means, such as lime, and the solution was hen electrolised at a low voltage and the copper eposited, and any final traces of iron which might e left were precipitated again by chemical means, ither lime, soda, or some similar re-agent, and then he nickel was extracted by another electrolytic urrent at higher tension. The process had only ust been started, but it seemed to give satisfactory esults and might play an important part in the ear future. The objection of Dr. Emmens to the rocess of Dr. Ludwig Mond, viz., that iron might e carried over, was one of very slight importance. By a proper regulation of the temperatures in he decomposition tubes it was easy to obtain ickel absolutely free from iron. The production f carbonic oxide in a pure state was also an easy natter, and as carbonic oxide was continually irculating through the apparatus it was a very mall loss which would occur, due only to leaks vhich could be reduced to a practical minimum. There was not the least difficulty about that. He lesired to thank Mr. Charleton for the great mount of valuable material which he had collected ogether.

Mr. WIGGIN said he had listened to the paper vith great interest, having been connected with the ickel trade all his life. It was wonderful how the uthor had been able to obtain so much information. Towards the close of the paper he said it probably vould not be long before the price of nickel was educed to 15 cents a pound. He hoped that would ıot be the case, but he regretted to say that at the resent moment it was being sold in England at ls. 1d. He hoped this paper would lead to a greater ctivity in the nickel steel industry, in which England was certainly much behind other countries. It ppeared that a great deal was being done in America, in Russia, in Italy, and also in Germany. England was proverbially slow in taking up anything new, but when she did she went into it thoroughly, and that probably would be the case in this instance.

Mr. J. T. VAUGHAN said he had heard the question of arsenic mentioned in conjunction with nickel, and that the arseniate of iron was passed as a bye-product, and was not utilised at all. He should like to know if that was so.

Mr. CHARLETON said he could not say definitely, but he believed it was used as some sort of wash.

Mr. VAUGHAN said the nickel from Norway contained a large quantity of arsenic, but that from Canada, he believed, did not.

The CHAIRMAN then proposed a vote of thanks to Mr. Charleton for the great time and labour he had spent in collecting so much information on this important subject.

The vote of thanks having been carried unanimously,

Mr. CHARLETON briefly acknowledged the compliment, and the proceedings terminated.

Miscellaneous.

THE VOLTERRA ALABASTER INDUSTRY.

The only cities in Italy in which alabaster is worked are Volterra, Florence, Leghorn, and Pisa. The city of Volterra, which is situated in the province of Pisa, thirty-two miles to the south-east of Pisa itself, is of immense antiquity, and its origin is lost in obscurity. It can, however, with some show of probability, be demonstrated, says Consul Chapmar, of Leghorn, that it was in existence four thousand years ago, and it would seem safe to accord its alabaster industry an almost similar antiquity. Volterra was one of the twelve cities of the Etruscan League. Its local museum, which is a model of good order and arrangement, contains nearly six hundred Etruscan cinerary urns of curious and beautiful workmanship. Fully two-thirds of these are made of alabaster, and are thus a convincing witness to the time-honoured antiquity of the alabaster industry. Speaking generally, alabaster is to be found nowhere in the world outside the province of Pisa. Consul Chapman says that sweeping as this statement may seem, it will yet stand the test of examination, provided there be no verbal misunderstandings. Original alabaster, the alabaster of the Bible, which is chiefly found in Egypt, is not what is nowadays ordinarily under-

stood by alabaster, but is really a species of marble; it is a carbonate of lime, whereas the alabaster of Volterra is a hydrated sulphate of lime, a distinction sufficiently emphatic to mark the sharp difference between the two. Then the alabaster found at St. Jean de Maurienne, in Savoy, is alabaster only by courtesy, for it is said to be of so poor a quality as to be only fit for conversion into plaster of Paris. The so-called Derbyshire alabaster is of much superior quality to the French, and it is even worked into ornaments and used in altar decorations, but it would seem to be so far inferior to the alabaster of Volterra as not to merit classification in the same category. Other sources of alabaster or alabaster-like substances might be indicated, Rellshall, in Tyrol, and Bormio, in Lombardy, for instance, but here again the poor quality of the mineral or the insignificance of the quantity leaves Volterra without any appreciable rival. The alabaster of common parlance is, then, solely and exclusively the alabaster of the district of Volterra and other outlying districts, all within the province of Pisa. The alabaster districts may be divided into two parts. In the first may be included all the caves (the word cave more accurately describing the nature of the workings, which are subterranean, than the word quarries) lying round about Volterra. The second division is composed of the communes of Castellina and Santa Luce, where, in the valley of the Marmolaio, are situated on the left bank the historic caves of Castellina, aud on the right bank the less known but equally important caves of Pomaia. The reason of this division is that the alabaster of the caves of the Marmolaio valley, which, following the custom of the dealers and workers of Volterra, is called Castellina alabaster, is in quality of a whiteness, a purity, and transparency not to be found in the alabasters of the other communes, and because it, and it alone, is used in that flourishing branch of the worked industry which is devoted to the sculpture of figures. There are many different varieties of alabaster found in the whole district—Dr. Targion Tozzetti, writing a hundred years ago, has elaborately described 52—but it will be sufficient for all practical purposes to divide the whole class into five clearly defined species, as follows:—The white alabaster of Castellina, a luminous and transparent stone of faintly cerulean tint; the white alabaster of Volterra, a mineral of an opaque, milky, and even creamy white colour; veined, striped, or spotted alabaster, in its many fanciful and beautiful varieties; Bardiglio, a greyish stone of the nature of alabaster, which, when cut and polished, has somewhat the appearance of the grey marble known as "dove" in the English trade; and finally, the agatized alabaster called at Volterra *agata*, an extremely beautiful yellow stone, varying in colour, when polished, from dark amber to deep, rich brown. The *bardiglio* is the cheapest, and the *agata* is the rarest and most expensive species of alabaster. The Castellina alabaster is especially prized on account of the large size of the blocks found. Nearly three-fifths of the alabaster f sculpture which is excavated at Pomaia is in bloc weighing at least six hundredweight, while bloc of from seventeen to twenty hundredweights are common occurrence. A block weighing fifty-eig hundredweights, and having a length of five feet an a quarter, was sent last year to the Antwerp Exhib tion. The working of the caves appears to be healthy one, and one of the foremen of the Venell caves informed Consul Chapman that the worke all lived to a good old age. They have a belief to that the fine white alabaster powder which the inhale in the process of picking, has strong hygien properties. The worked alabaster industry is divide into two strongly differentiated branches; firstl sculpture, that is to sculptured representation whether on a large or small scale, of the huma form, and secondly, the miscellaneous industry. Th latter comprises the countless other objects manu factured at Volterra, such as vases, ewers, pillar and stands, baskets, clock-cases, frames, toile necessaries, animals, fruits, ash-trays, candelabr crucifixes, holy water stoups, &c. Nearly all th best sculpture of alabaster is now carried on i Florence, whereas the miscellaneous industry i almost confined to the city of Volterra. As regard the latter branch a great change has passed over thi industry in the last twenty years. In former day there were three distinct classes of workers. Firs the master artist or master worker (*capo fabbrica* who owned a large workshop and employed numerou workers, selling his products direct to the alabaste shops, or galleries, as they are called, of Leghorn Pisa, Florence, and Volterra. Secondly, the journeymen workers (*lavoranti*), and thirdly, the traveller (*viaggianti*), men who travelled not merely wit samples but with huge cases of the goods, selling them as they went along. The master worker and the traveller are now extinct species. The moderr system of labour and distribution is entirely different. Walking along the by-streets of Volterra the ear is arrested by the clinking of little hammers, or the grating rasp of files, and looking at a doorway the passer by will see two or three men busily engaged with all the application of true artists in fashioning the various parts of a vase or a flower basket. These men may be a father and his sons, or three men united in an informal partnership, and they usually unite in themselves the qualifications required in the production of a vase, one being a turner (*tornitore*), who gives it shape; the other a modeller (*squadratore*), who fashions its pillar and base; the third a decorator (*ornatista*), who carries its adjuncts of fruit and flowers. The master worker with his busy band of workers and apprentices has disappeared, and it is from these small workshops that the articles of the miscellaneous alabaster industry now go forth to the world. The great cheapness of the objects in alabaster—probably only by the hardy frugality of the workers and the low cost of living at Volterra—has tended to cast an undeserved slur upon the industry.

› cheap are the smaller articles that many people e led to believe that they must be produced in some ıy by machinery. The humble vendor who boards British ship in Leghorn harbour to display his ıres, is often met with sceptical incredulity when he plains that all the articles he has for sale are the oduct of patient home labour. An industry exists Pomaia, in the commune of Santa Luce, which will new to many people—it is the transmutation of abaster into a very fine imitation of coral. The vention is that of a Frenchman, and the chemical ocess by which the alabaster takes the colour is ill a trade secret. The colouring matter completely ermeates the stone, and when a bead of this imitation ral is broken, it has all the appearance of the enuine article. Only two factories for turning out abaster coral exist in Europe. The first was set up the inventor at St. Claude, in France—in the epartment of the Jura—and the second at Pomaia, close proximity to the rough material.

EVELOPMENT OF THE COAL AND IRON INDUSTRIES IN SOUTH RUSSIA.

M. Pillez, on his return from a journey in Russia, ıs communicated to the Société de l'Industrie inérale some notes on the coal and iron industries, om which the following particulars are taken:—

The Donetz coalfield, the most extensive of any in urope, having an area of 9,225 square miles, conins immense mineral wealth, consisting of every escription of coal, from anthracite to the flaming riety.

Up to 1870 there were no ironworks in the Donetz istrict that did not belong to the Government, who ıd endeavoured to found works at Petrovsk and issitchansk, but without success; though, from '96, a single establishment—that of Lougansk, for aking war material—struggled through a century ainst the most varied fortunes, and was closed in 87. In 1869-70, an Englishman, John Hughes, ıt up two blast-furnaces at Youzowo; and the ussian, Pastoukof, constructed a blast-furnace, to fired by anthracite, near the Souline Station of e Vorontche-Rostof Railway. The two works ove mentioned smelted ores from their immediate ighbourhood, containing on an average 45 per cent. iron. The production of pig-iron was about ,800 tons, this state of things continuing until 1885. It should be mentioned that a Frenchman, M. Le ay, mining engineer, studied the Donetz region so rly as 1837, and then drew the attention of the dustrial world to numerous coal deposits that he d discovered.

In 1883, the Katharine Railway was begun, for nnecting the Donetz coalfield with the Krivoiog iron mines; and, at the same time, the Governent increased the import dues on pig-iron from out 10s. to 30s. per ton. In 1887, a further crease of duty brought up the import dues to £3 per ton; and it is under the influence of this new state of things that fresh ironworks were put up in 1885 and 1886. The Briansk Company founded works in the Government of Orel, central Russia, for rolling rails from pig-iron, as the duty was then moderate. At Warsaw also, the Dnieper Company founded works for turning out rails and steel made from foreign pig. Under the influence of the increased customs dues about 1885–6, and the development of railways, the Briansk company built two blast-furnaces, now called the Alexandros Works, at Ekaterinoslav, on the Dnieper between the Donetz coalfield, and the Krivoi-Rog iron mines. At the same time the Warsaw Company put up two new blast-furnaces at what are now called the Kamenskoe Works, fourteen miles from Ekaterinoslav, in connection with the Cockerill Company of Seraing, Belgium.

During the last few years the Hughes and two other works above-named have greatly increased, and the Pastoukof establishment, which was idle for a long time, resumed working. In 1893 the Huta-Bankova Company at Dombrova, in Russian Poland, founded the Donetz Ironworks at Droujkofka, to the north of the coalfield near Konstantinovka, on the Karkhof-Azof Railway, where there is already one and there will soon be two blast-furnaces. There are, moreover, two blast-furnaces, one belonging to the Krafte Company at Kremenchouk, on the Dnieper, and another lately blown in at Krivoi-Rog.

To sum up, in 1885 there were in South Russia three blast-furnaces turning out 41,800 tons of pig-iron, and in 1894 twenty furnaces turning out about 500,000 tons, so that in eight years the out-turn has increased more than tenfold. These blast-furnaces are thus distributed:—Hughes Works 5, Briansk Works 5, Dnieper (Warsaw) 4, Krivoi-Rog Works 1, Pastoukof Works 2, Droujkofka Works 2, and Krafte Works 1; total, 20.

These twenty blast-furnaces, which for the most part smelt Krivoi-Rog ores containing from 60 to 65 per cent. of iron, with a smaller proportion of other ores containing from 40 to 45 per cent., and manganese ores obtained from Nicopol on the Dnieper, turn out an average of seventy tons per furnace every twenty-four hours. All the pig-iron prodnced is worked up on the spot into rails, merchant iron, steel, and various finished products; and the quality of coal consumed has exerted great influence on the rapid development of the Donetz coalfield. The following figures show the increased output in tons of coal and anthracite:—

	Coal.	Anthracite.	Total.
1870	43,800	266,950	260,750
1880	951,100	487,000	1,438,000
1885	1,372,000	543,000	1,915,000
1893	3,152,000	672,000	3,824,000

It will be seen by the above that between 1885, when an impetus was given to the iron manufacture, and 1893, the output of coal was more than doubled; the production of anthracite, however, does not appear to have much increased, as the demand for this class of fuel is limited. It is natural to suppose that the manufacture of coke should also have largely increased during the last few years. Only a short time ago it was made in open ovens on the Shauenburg system, but many closed ovens, called Belgian, of various types are now being built. About 900 of these exist, and others will be put up for superseding the open ovens now existing, but of which no more will be constructed. Moreover, the production of pig-iron is only in its infancy in this immense, undeveloped country, where the Government is anxious to utilise the great mineral wealth at command.

General Notes.

Production of Champagne.—The Chamber of Commerce of Reims has published an article on effervescing wines since 1861, from April to April. In the year 1861-62 there were in the cellars of the wholesale merchants 30,254,291 bottles; in 1893-94 there were 86,771,994 bottles and the largest stock ever held. In the former year there were sent abroad 6,605,000 bottles, and 2,593,000 consumed in France; total 9,198,000 bottles. Last year there were shipped to foreign countries 17,359,000 bottles, and consumed in France, 4,876,000; total 22,235,000. The foreign consumption has retrograded since 1891 and 1892, but still the production increases.

MEETINGS OF THE SOCIETY.

Applied Art Section.

Tuesday evening, at Eight o'clock:—

May 28.—"The Decoration of St. Paul's." By Prof. W. B. Richmond, A.R.A. The Very Rev. the Dean of St. Paul's will preside.

Cantor Lectures.

Monday Evenings, at Eight o'clock:—

Ernest Hart, D.C.L., "Japanese Art Industries." Two Lectures.

Lecture II.—May 27.—Japanese bronzes, ancient and modern—Ornamental metal work—Shakudo, shibuitchi, antimony—Cloisonné and other enamels—Wood engravings and hand block-colour-printing—Photographing.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Ernest Hart, "Japanese Art Industries." (Lecture II.)

Surveyors, 12, Great George-street, S.W., 3 p. Annual Meeting.

Geographical, University of London, Burlingt gardens, W., 2 p.m. Annual Meeting.

Tuesday, May 28 ... SOCIETY OF ARTS, John-str Adelphi, W.C., 8 p.m. (Applied Art Secti Prof. W. B. Richmond, "The Decoration of Paul's."

Royal Institution, Albemarle-street, W., 3 p Prof. E. Ray Lankester, "Thirty Years' Prog in Biological Science." (Lecture III.)

Central Chamber of Agriculture (at the House the Society of Arts), 11 a.m.

Medical and Chirurgical, 20, Hanover-square, 8½ p m.

Civil Engineers (in the Theatre of the United Serv Institute), Whitehall, S.W., 8 p.m. Ann Meeting.

Photographic, 50, Great Russell-street, W.C., 8 p Mr. Birt Acres, "Polychromatic Carbon Printin

Wednesday, May 29 ... Sanitary Institute, Parkes Musei Margaret-street, W., 2 p.m. Mr. Arthur Collins, "Scavenging, Disposal of Refuse Sewage."

Thursday, May 30...Institute of Mining Enginesrs (at House of the Society of Arts), 12 noon. 1. W. N. Atkinson, Presidential Address. 2. George G. Blackwell, "Notes on Bauxite County Antrim, &c., and its Uses." 3. Mr. Clarkson, "Sampling." 4. Mr. A. R. Saw "Remarks on the Banket Formation of Johann burg, Transvaal." 5. Prof. Vivian B. Lew "Blasting Explosives." 6. Mr. A. G. Charlet "The Gold-Milling Process at Pestarena." 7. L. van Werveke, "The Mineral Oils of Lo Elsass." 8. Mr. Robert Oates, "Copper-Min in India." 9. Mr. Joseph R. Wilson, "The Sh Gas-Tester for Detecting the Presence and P centages of Fire-damp and Choke-damp in C Mines, &c." 10. Messrs. W. N. Atkinson J. S. Haldane, "Investigation on the Compositi Occurrence, and Properties of Black-damp." Mr. Edmund Spargo, "Lithographic Stone and Uses."

Society for the Encouragement of Fine Arts, Conduit-street, W., 8 p.m. Mr. J. Starkie Gar ner, "Iron Work: the Grand Period."

Royal Institution, Albemarle-street, W., 3 p Dr. W. Huggins, "The Instruments and Meth of Spectroscopic Astronomy." (Lecture II.)

Friday, May 31...Institute of Mining Engineers (at House of the Society of Arts), 10 a.m. 1. Pr Frank Clowes, "The Composition of the Extin tive Atmospheres Produced by Various Flan and by Respiration." 2. Prof. Frank Clow "The Composition of the Limiting Explos Mixtures of Various Gases with Air." 3. Prof. W. Rucker, "The Recent Magnetic Survey of United Kingdom." 4. Mr. J. T. Denny, "T Thwaite-Denny Gold Extraction Process and Practical Application to the Banket Ores South Africa." 5. Mr. John McConnell, "T MacArthur-Forrest Process."

Royal Institution, Albemarle-street, W., 8 p. Weekly Meeting, 9 p.m. The Earl of Ros "The Radiant Heat from the Moon during progress of an Eclipse."

Saturday, June 1...Royal Institution, Albemarle-stre W., 3 p.m. Prof. Edward Dowden, "Elizabeth Literature." (Lecture I.—"The Pastoral.")

ournal of the Society of Arts.

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FRIDAY, MAY 31, 1895.

communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take ce at the South Kensington Museum (by mission of the Lords of the Committee of uncil on Education), on Wednesday, June h.

The reception will be held by Major-General John Donnelly, K.C.B., Chairman, and Members of the Council of the Society, m 9 to 10 p.m.

Each member is entitled to a card for him-f, which will not be transferable, and a rd for a lady. In addition each member ll be able to purchase two transferable kets, the price of which will be 5s. ch up to the day of the *conversazione*; that day the price will be raised to . 6d. It is requested that members requiring ese additional tickets will make early appli-tion for them. Every application must be companied by a remittance.

Promenade Concerts will be given in the orth Court and in the Textiles Court of the useum, commencing at 9.15 p.m.

A Glee and Madrigal Concert will be given intervals in the Lecture Theatre, com-encing at 9.30 p.m.

A Vocal and Instrument Concert will be ven in one of the galleries of the Museum, mmencing at 9.30 p.m.

Light refreshments (tea, coffee, ices, claret p, &c.) will be supplied at the usual Re-eshment Buffets in the Central Corridor of e Museum.

As the old Museum quadrangle is now vered in, none of the entertainment will in the open air.

Further particulars as to the musical and her arrangements will be given in the pro-amme, which will be distributed on the ening.

Cards of invitation are now in course of issue.

TECHNICAL INSTRUCTION CONFERENCE.

The following letter has been addressed to representatives of Technical Education Committees, and others interested in the subject :—

"Society of Arts,
"Adelphi, London, W.C.
"*May*, 1895.

"Sir,—It has been suggested to the Council of this Society that a useful purpose would be served if the Society were to afford to those who are interested in Technical Education in different parts of the country an opportunity of meeting together, and discussing the measures which the Society might take with a view to enlarge the scope of its present action in this matter, and thus aid local authorities in giving effect to recent legislation on the subject.

"There appears to be a lack of a central organisation which might deal especially with such questions as the examination and inspection of classes. In spite of the valuable work which has been done by the City and Guilds of London Institute, and by other bodies, it is only in a portion of the subjects sanctioned as subjects of technical instruction that examinations are held. The wide field of agriculture and home industries is untouched; while no means are provided for anything like a general system of inspection which local authorities may call to their aid should they desire to do so.

"There are also other points with regard to which common action would be desirable, and the Council of the Society have, therefore, determined to hold a Conference of Representatives of the Technical Instruction Committees of the various County Councils and others, with the view of eliciting their views on the subject. It is proposed to hold this Conference on the 20th of June next, and to invite to it the Chairmen of the Technical Instruction Committees, or other representatives who may be delegated by such Committees, and their Directors or Organising Secretaries.

"I shall be glad if you will let me know whether you can yourself attend the meeting, and also whether your County Council will depute any members of its Technical Instruction Committee to attend.

"I have the honour to be, Sir,
"Your obedient Servant,
"Henry Trueman Wood,
"*Secretary*."

EXAMINATIONS, MARCH, 1895.

The results are nearly ready. They will be issued in a few days to the various centres of examination, and copies of the list sent for distribution to the successful candidates.

CANTOR LECTURES.

On Monday evening, 27th inst., Mr. ERNEST HART delivered the second and last lecture of his course on "Japanese Art Industries."

On the motion of the CHAIRMAN (Mr. F. Cobb), a vote of thanks was passed to the lecturer.

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday, May 23; SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., Vice-President of the Society, in the chair. The paper read was—"The Northern Balochis; their customs and folk-lore." By Oswald V. Yates, A.M.Inst. Civil Engineers.

The paper and report of discussion will be published in the number of the *Journal* for June 14th.

APPLIED ART SECTION.

Tuesday, May 28; the VERY REV. the DEAN of ST. PAUL'S, in the chair. The paper read was—"The Decoration of St. Paul's." By Professor W. B. Richmond, A.R.A.

The paper and report of the discussion will be published in the number of the *Journal* for June 21st.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

APPLIED ART SECTION.

Thursday afternoon, May 7, 1895; H.R.H. THE PRINCESS MARY ADELAIDE, DUCHESS OF TECK, in the chair.

The paper read was—

ON THE IMPROVEMENTS IN TH DESIGNING, COLOURING, AND MANU FACTURE OF BRITISH SILKS SINC THE EGERTON EXHIBITION OF 1890.

By THOMAS WARDLE.

INTRODUCTION.

The objects of this paper, and of this mee ing, are twofold, one to endeavour to prov that the art of decorating silken fabri in Great Britain has rapidly improve since the date of the first Silk Exhibitio held under the auspices of the Ladie National Silk Association in 1890, and that can now hold its own amongst the best decora tive effects of other countries. Second, to sho that the advanced designing and colourin is being applied so successfully as t deserve the attention and preference of ou countrywomen, and more especially of thos of them who have with so much patriotis come to the front to assist in the restoration o the British silk industry to at least that posi tion of importance which it occupied 50 year ago.

In 1886, the Council of the Society of Art organised its "Applied Art Section." Th object of this section was to stimulate effort by the reading of papers and by discussio for the retention and expansion of thos national industries which are, perhaps, mos succinctly described as the arts and crafts.

In April, 1892, Mr. Purdon-Clarke read most useful paper on "English Brocades an Figured Silks," and in 1893 a very instructiv paper, with lantern illustrations, was read b Mr. Paul Schulze, Director of Art at th Royal Silk Weaving School at Crefeld, i Germany. This paper was published in th *Journal* of this Society (vol. xli. p. 533) It is copiously illustrated, and I woul particularly refer my hearers to it for in formation on historic patterning.

To-day I have the honour of speaking of th British silk industry, and the progress made i British silk manufacturing since the Egerto Exhibition of 1890, the date at which a definit start was made to recover lost ground.

TUSSUR SILK.

In 1891 I had the honour of being selecte to read a paper in the Indian Section on "Th

tory and Growing Utilisations of Tussur :." Lady Egerton of Tatton presided, and were told at the time by Sir George Birdwood t it was the first occasion in the history of ; Society on which the chair had been upied by a lady.

'welve years before that time no Tussur silk ; used in France, but to-day the record is ›ortant, for the quantity conditioned in ›ns during the last five months has raged over 16,300 lbs. weekly, and this hout reckoning the large consumption in many, Switzerland, America, and England. 'o-day we are graciously favoured by having r Royal Highness in the chair, and thus we e the added testimony of your Royal Highs's interest in the great national importance he subject to be discussed.

'rom the first moment it was decided t this was, in a great measure, a ladies' stion, and that the ladies of this country l empire could usefully assist in the effort of ıging the silk industry of this country to its ner state of importance and success, ır Royal Highness graciously and generly took the lead, and formed the dies' National Silk Association of Great tain and Ireland. I should like to be mitted to state its precise objects as, at st, one of them is pertinent to the special t of the subject we are met to consider lay.

'hese are, first, to call the attention of ladies the fact that British silks were not having air chance of being known or even seen, so cured were they in the markets by the pro-ts of foreign looms.

econdly, to prove to ladies that British silks e not so *outré* or devoid of beauty and ex-ence or so dear as they had for so long been ght to believe.

'hirdly, to induce distributors in London l the country, and the all-powerful dress-king interest, to show side by side British h foreign silks, and to give a preference hose of home manufacture when they were choice and as cheap as foreign silks. At t time, 1891, ladies would not knowingly ' an English silk simply because it *was* glish, and distributors would not offer them the same reason.

'ourthly, and not the least important, to ladies of taste, particularly those county y secretaries whom your Royal Highness l succeeded in inducing to undertake the ce, to do what they could to put be-: the silk manufacturers the artistic requirements of ladies, particularly for dress purposes, and to suggest improvements in design and colouring; to encourage novelties; and to urge them to be in advance instead of behind foreign producers in styles to suit every coming season's fashions.

Great effect was given to this fourth idea at the Stafford House Exhibition last year, when a number of designs for dress silks were exhibited; and this year, as an outcome of the Stafford House Exhibition, her Grace the Duchess of Sutherland has generously offered to the students of the various schools of art of the pottery towns of North Staffordshire, and of Macclesfield, Leek, and Manchester, a prize of £5 for the best design for a silk dress. I trust this excellent example will be followed by other ladies.

Your Royal Highness has not been behind in this respect by both designing excellent patterns, as several fabrics on these walls now testify, and selecting others, as well also by giving excellent advice on economic and decorative points when visiting the various centres of the silk industry.

Happily, through the efforts of the Silk Association of Great Britain and Ireland, and chiefly of the Ladies' National Silk Association, a growing public attention is being given to silks of home manufacture, and the silk industry is showing some signs of being roused from the lethargic and depressed state into which it had unhappily fallen since those more flourishing times prior to 1860, the year of the treaty with France, when Mr. Gladstone repealed the 15 per cent. duty on silks of foreign manufacture. From that time the industry gradually fell to pieces, and with it the textile prosperity of Spitalfields, Coventry, Dublin, Derby, Leek, Macclesfield, Congleton, Manchester, Middleton, and other silk centres. Whatever opinions may be held of the fiscal wisdom of this policy, no one acquainted with the history of the silk industry in this country for a moment doubts that its rapid decline dates from that repeal of duty on foreign silks, and was caused by the inlet thus afforded of the results of economies in production, which cheaper continental labour supplied in those days of universal hand-loom weaving, coupled with the great advantage enjoyed by the French in having Paris as the centre of European fashion, and of the selection of styles in silks for dress purposes. Besides this, the privilege and security which this formidable wall of protection of 15 per cent. had so long given to English manu-

facturers, had lulled them into supineness respecting the important points of style, taste, variety, and the study of the laws of harmonic colouring; from which neglects the destructive fiscal change effected by Mr. Gladstone was inevitably destined to give the home industry a rude awakening. In addition to this, the continental dyers had begun to discover the unique and curious affinities of the fibre of silk for the absorption of metallic salts and vegetable weighting matters, of which they held a monopoly of knowledge for a long time, and which materially cheapened the manufactured fabric, though it must be said to its deterioration, and frequently to its destruction, as I hope to show presently. The harking back that is now commencing to a preference for unweighted silks is operating in favour of the home manufacture, and helping to give it a more equal chance in that price competition which is so all-important a factor with the merchant dealer.

History of the English and French Silk Industries.

The Board of Trade returns give conclusive evidence of the beginning of the decline of the English silk trade. In 1860, our imports of manufactured coloured silks from the continent of Europe amounted in value to only £3,343,761. The following year they sprang up to £5,908,029, and yearly kept on increasing until, in 1870, they reached the gigantic figures of £11,908,814. From that time the importation averaged about £12,000,000 per annum, but last year the amount reached £12,749,005, which, had silk retained its normal value, would have been more than £19,000,000, but the unparalled low price of raw silk reduced the value to the former figure.

In 1860, the imports of raw silk amounted to £9,178,647, from which time the amount in raw silk imports has gradually declined; it only totalled, in 1883, £3,178,593, and last year, £1,463,981. When Cobden was told that this would inevitably be the effect of abolishing the duty of 15 per cent., he is said to have replied, "Let the silk trade perish, and go to the countries to which it naturally belongs;" but, without venturing upon debateable ground, I assert that the silk trade was settled in this country more than a century and a half before silk was manufactured in Lyons, and therefore naturally belonged to this country. It found in England a better manufacturing climate, and better water for dyeing purposes, than in any other country which had received its migration from the far East; a it cannot be that it does not as natura belong to England as to any other Europe country.

The silk industry was an English one as ea as 1363 (reign of Edward III.), as is shown an Act of Parliament of that date. It was t date of the late Gothic times in England, a of the Renaissance in Italy, famous for beautiful patterned stuffs in Genoese, Flore tine, Lucca, and Venetian velvets and brocad The excellence of the pattern designing a silk weaving of that time is most interestin shown in the illustrations of the contempora figured vestments and clothing in the pictu of Andrea Orcagna, Fra Angelico, Crive Paulo Veronese, and other great Venetian a Tuscan masters in the National Gallery, ma of whom, particularly Carlo Crivelli, I have doubt were pattern designers as well painters.

The taste and art of dress of that peri and the culminating ceremonial of worship our English cathedrals and churches, doubt caused artistic silk weaving to be int duced into England at an early date. Engli dyers were known to be an incorporated bo as early as 1188.

If the manufacture of paper from ra can be traced back to so remote a time 1300, it need not be wondered at that o artistic forefathers would not be slow to lea from the Sicilian and Italian weavers of tho days the beautiful and artistic results obtain by their dyeing and artistic patterning brocades and velvets, made of so lustrous ar delicate a fibre as that of silk.

Thus then we were greatly ahead of Franc The manufacture of silk was introduced the in 1480, and did not get a foothold into Lyo until 1520, that is 40 years after its introdu tion into other parts of France, and 157 yea after its introduction into England.

We have, therefore, every historic and artist reason for being proud of our silk industr and it is natural and commendable that w should have the strongest desire, and the mo persevering determination, to uphold our fam and commerce as silk workers, and not to allo ourselves to be deprived of so beautiful a industry by any causes which are preventible.

Herein is the *raison d'être* for the ex tensive presentment of silk on this impor ant occasion, and for your Royal Highnes and the Ladies' National Silk Associatio seeking this and every opportunity of asser ing and proving that, for many years past-

ving to the mysteries of distribution, Paris essmaking, and other causes—the ladies of is country have been made to lose sight of e improved excellence and artistic value of e silks of British manufacture, whether for rsonal or household decoration. The Association also seeks to show that the so-called eapness of foreign-made silk is more appant than real, and that, in the absence of the ordinate falsification by chemical weighting for some years past so extensively resorted to abroad, English dress silks, in these ys of the power-loom, which has now supanted the hand-loom, can be made as cheaply those of the Continent. They are at last finding out that the cheapness of foreign silks is pparent only, and that cheapening by chemil adulteration to such a frightful extent as now carried on—in many cases to several ndreds per cent. of the original weight of e silk—is but analogous to the sanding of gar, and the reverse of economy.

But the truth must be spoken, and time as, and not so long ago, when those ho had to supply the wearers and users of lk complained—and with some cause—that t and manufacture had almost parted comny in the production of silk fabrics. A neration ago, even the silks of Spitalfields, rmerly so celebrated, were accused of having generated into something of dowdiness. No nder that wholesale buyers sought in the re artistic markets of the Continent for the re attractive stuffs. But when the English asters of production became aroused, a change ok place, and the divorce between art and aving was healed. British silk manucturers are now hailing every opportunity orded them of showing the advance made them in the designing, colouring, and nufacture of their productions.

English Silk Exhibitions.

The first silk exhibition, with its many imfections, held at London, in the House of rd Egerton of Tatton, under the auspices of late Lady Egerton of Tatton, in 1890, was first outcome of the revival; the second—nittedly a manifest artistic advance on the t—was held under the presidency of your yal Highness and the auspices of the chess of Sutherland and the Ladies' tional Silk Association at Stafford House, t year.

third, and artistically still more successful ibition, was held at Stafford House in March . It was opened by your Royal Highness, when many of the principal silk manufacturers, county drapers, and upholsterers vied with each other in exhibiting silks of greatly improved design and manufacture, and in expressing themselves highly favourable to the movement and opportunity.

A fourth exhibition of silks, chiefly for dress purposes, of Macclesfield manufacture, was held at Macclesfield on Tuesday, the 16th April last, on the important occasion of the visit of your Royal Highness to that town. Several of the most artistic fabrics exhibited there have been kindly lent for this day's exhibits. The reception of your Royal Highness on that successful occasion was worthy of the people of Macclesfield, and the demonstrations of their heartiness and enthusiasm that day will I am sure never be forgotten by your Royal Highness. A county exhibition for Cheshire is now being projected at Chester.

For several years—both in public and private—I have urged the Macclesfield silk manufacturers to turn their attention to the manufacture of artistic dress fabrics, as an additional branch of the staple trade of handkerchiefs, neckerchiefs, and sarcenets, for which they have for so long been justly celebrated. At first the suggestion fell unheeded, as if, after the decline of their staple, the deluge must follow; but for some time past the idea has been taking root, and several manufacturers have shown themselves capable of producing dress silks of a highly artistic degree of excellence, both in designs and colouring, as many of the silks in this room testify.

The visit of your Royal Highness to Macclesfield undoubtedly has driven this idea home, and there is every indication of an extensive dress trade springing up, which will not only supply the deficiency of kerchief weaving, but will, I have no doubt, become in due time the predominating feature of the ancient industry there.

Indications were not wanting on that day in support of this forecast. Gentlemen from the important silk-buying departments of Messrs. J. & N. Philips and Co., Messrs. Rylands and Sons, Limited, and Messrs. Kendal, Milne, and Co., of Manchester, assured me of their intention of giving all the encouragement and support they could to the home industry, and pointed out to me with great satisfaction many silks in the Exhibition which had been manufactured to their respective instructions and orders, one of those firms having offered to purchase the greatest portion of the rest of the

silks for the purpose of publicly exhibiting them in Manchester.

What a desirable change of opinion! A few years ago it was next to impossible to induce the large merchants and distributors of London and Manchester to look at English silks. It was often said, and with some truth, that the distributors were the *bêtes noirs* of the British silk trade; but now they should be regarded with gratitude by the manufacturers and their workpeople upon such a happy change of opinion, and one which, if manufacturers are equal (as I feel sure they will be) to the requirements of the distributors, who so well know the tastes of their lady clients and the coming changes of fashiou, should dissipate all fear for the future of the British silk industry. Out of the £13,000,000 worth of foreign manufactured silks purchased by England last year, £11,000,000 worth were for home consumption, and only, as I have elsewhere shown, a little less than £2,000,000 worth for exportation. This shows that our home requirements, whilst large enough to make all our home silk centres prosperous again, still leave a large margin to be supplied by foreign looms. It is well, too, that the distributors should press forward the revival of home manufactures, as London is gradually losing its export trade in silk; only £2,000,000 worth out of the £13,000,000 imported last year being re-exported. This, I expect, is owing to purchasers buying direct from the continental merchants instead of, as formerly, buying through London.

That English silks have remained under a cloud for many years past is well known, but I am glad now to be able to report that the present movement is beneficially affecting the industry, as is very tersely expressed in a letter I have lately received from one of the oldest dress-silk manufacturers in England, in the following words :—"There is improvement in the silk trade; last year's exhibition has done us good. There is now a disposition on the part of the wholesale buyers to look at English silks because they are English, where formerly they would not entertain them for the same reason."

English Silk Statistics for 1892, 1893, 1894.

The following statistics are quoted from the Board of Trade returns by the *Bulletin des Soies*:—

"The English imports of manufactured silks for 1894 show a very important increase over prece years. They amount in fact to £12,749,035 sterl against £11,728,406 sterling in 1893, and £11,412, sterling in 1892. These imports consist of all cla of silk goods, but are chiefly piece-goods."

Importation of Manufactured Silks i England.

	1892.	1893.	1894
Broad silks	5,191,507	6,304,777	7,057,
Ribbons, silks, and satins	2,626,316	2,392,256	2,641,
Ribbons of other kinds	122,521	121,260	131,
Other kinds of silks ...	2,771,869	2,910,113	2,919,
	11,412,363	11,728,406	12,749,

"Now, on the other hand, if we scrutinise particulars of manufactured silks exported fr England, which comprise, without doubt, a nota quantity of foreign-made silks in the London mark we find a contrary state of things, namely, a dimi tion of exports on the preceding years, as shown the following Table :—

Exportation of Silk from England.

	1892.	1893.	1894.
	£	£	£
Broad silks, satins........	262,483	235,716	251,3
Handkerchiefs, scarves, shawls	446,486	430,470	272,3
Ribbons of all sorts......	8,506	16,276	20,9
Tulle	338,521	240,506	163,1
Other articles of pure silk	159,654	141,169	146,4
Mixed goods	439,660	400,664	367,7
	1,655,310	1,514,803	1,221,96

English Re-exportation of Foreign-made Silks.

	1892.	1893.	1894.
	£.	£.	£.
Piece goods..............	353,275	307,795	253,066
Ribbons	234,621	272,876	251,725
Other articles...........	143,420	130,964	115,111
	730,316	711,435	619,902

"The character of the London market, as a plac of international sale, becomes gradually more feebl as the exports of English silks, properly called, los more and more ground. The diminution is the mor important from the fact that it consists chiefly i mufflers (*mouchoires-écharpes*), which form one c the principle articles of British manufacture, and als in Nottingham lace."

(Let me here remark that the loss of th muffler trade affects Macclesfield, and is th result of the French having put on a duty o

[p]er cent. about two years ago. This is also [th]e case with silk lace.)

[T]he article goes on to say:—

"If of the British exports we discriminate between exports and re-exports, we find English consump[tio]n to be according to the following figures:—

	1892.	1893.	1894.
	£.	£.	£.
[En]glish imports of [f]oreign silks.........	11,412,363	11,728,406	12,749,035
[En]glish exports and [r]e-exports............	2,385,626	2,226,228	1,841,863
[En]glish consumption.	9,026,737	9,502,178	10,907,172

[Th]e greatly increased consumption in England is [the]n very marked."

[H]ISTORY OF SILK PATTERN DESIGNING: EGYPTIAN, GREEK, ROMAN, PERSIAN, COPTIC, BYZANTINE, SARACENIC, ITALIAN, FRENCH.

SILK TEXTILE PATTERNING. ITALIAN RENAISSANCE.

Andrea Orcagna............	1329–1389
*Fra Angelico	1378–1455
*Carlo Crivelli	1468 ?–1493 ?
†Paulo Veronese	1528–1588
†Raphael	1483–1520
†Michael Angelo	1474–1564

FRENCH ART PERIODS.

Henri IV.	1589–1610
Louis XIII.	1610–1643
Louis XIV.	1643–1715
Louis XV..................	1715–1774
Louis XVI.	1774–1789
Revolution	1789–1794
Empire	1804–1814

ENGLISH.

Elizabeth	1558–1603

[H]ISTORY OF SILK PATTERN DESIGNING.

[I] hope it will not be considered too great a [di]vergence from my subject if I attempt a very [bri]ef outline of the history of silk pattern de[sig]ning. It is not necessary to be more than [bri]ef, because Mr. Paul Schulze, in this room in [Ap]ril last year but one, treated this subject very [lea]rnedly; and his largely-illustrated paper [wa]s published in the *Journal* (vol. xli. p. 534). [H]e commenced by telling us of Egyptian [or]nament of several ancient dynasties, and [of] Assyria; then of Greece, in which animals [for]med the most prominent features, and of [Ro]man-patterned textiles. That time was followed by the interesting patterning of the ancient Egyptian Christians, found by Mr. Flinders Petrie upon the clothing of the dead in the Coptic tombs of Upper Egypt, on which garments, men, women, and the lower animals and symbols were represented in storied sequence so far back as the third and several later centuries. Persian silk weaving at this time was in the ascendant, that is, in the 6th century of our present era. Here is an example which is a reproduction of a reliquary cover from the Church of St. Servatius of Maestricht. It is a piece of Persian figure-weaving of the 6th century, made under the government of the reigning family of the Sassanide kings. Its meaning is a hunting scene, in which two Persian kings on horseback, hunting lions, take part. Between the circles are woven the Tree of Life, the Hom of the ancient Assyrians. This will serve as a type of Persian textile patterning, and to fitly exemplify this rapid sketch of the evolution of textile ornamentation, and to show that the chief thought in the minds of those who made the patterns was the expression of some motive and of some meaning. From this period, patterning merged into the Byzantine treatment of ornament, which influenced this branch of art from the 6th to the 13th century. The use of the lion was prevalent in allusion to the royal lion of the tribe of Judah representing our Saviour, and of other meanings.

Here is a Byzantine illustration of another kind. It is a *fac simile* reproduction of the patterning of the garment in which the German Emperor Otho the Great was buried in A.D. 973. I possess a small portion of the original stuff which is of silk. The period of the decline and decay of Byzantine art brings us to the art of the Mahometans and to their power of conquest, which made them masters of Byzantium (now Constantinople), and with it Turkey, in 1453. The Saracens, an Arab race, the first disciples of Mahomet, became masters of Spain in 711, and Sicily in 832, where they established their Saracenic arts, notably those of silk weaving and dyeing. The Normans conquered Sicily after this period, and in the 12th century Roger the Second gave encouragement to the cultivation of silkworms and to silk weaving. He established at Palermo a royal silk factory called Hotel de Tiraz, a portion of the royal palace of the Saracens of the 9th and 10th centuries. Roger employed both Saracenic and Greek weavers, and the evolution of designing received a great impetus; it is represented by the symbolic animals and draw-

* Quatrecentro. † Cinquecento.

ings shown in the lithographs on the wall, from valuable old textiles now preserved in churches and museums. It was at this period that symbolic designing reached its highest development. For example, this drawing of a lion seizing a duck, representing government, and pursued by an eagle, meaning good luck and riches. The lion and hoopoe signify wisdom. Here is one of two stags kneeling under the sun's disc, from which radiate sunbeams yielding dewdrops. This refers to the verse in the psalm, "As the hart pants for cooling streams, so longs my soul for Thee, O God."

From Sicily the art travelled to Lucca, Milan, Florence, Bologna, Venice, and Genoa, and up to the dawn of the 14th century the designs were but modifications of Saracenic creative talent but yet always having meaning.

Here is a reproduction of one, probably from Lucca looms. It possesses great beauty, both in motive and in drawing. Mr. Schulze thus describes it:—"The dog, the symbol of the human soul, has been freed from this mortal life, as indicated by the broken chain; the eagle, the symbol of divinity, having descended from heaven to break the chain, now steers the soul to the abode of the blessed, and this action takes place under the shade of the great and mighty tree of the Church. This design was probably made for funerals."

From this time, or during the whole of the 14th century, came gradually in the splendid pattern designing of the Italian Renaissance, the close of which may be considered contemporaneous with Raphael and Michael Angelo, or (say) of the middle of the 16th century. There are some patterns from Crivelli's pictures in the National Gallery copied by Mr. Sidney Vacher. They have such a family resemblance to each other as to point very distinctly to Crivelli's skill as a pattern designer. The influence continued onwards to the time of Paolo Veronese, or nearly to the end of the century.

The liking for the representations of animals in woven fabrics had, during this time, gradually given way to very conventional treatment of foliage, fruit, and flowers, in formal diaper work, with much Gothic influence. It was never naturalistic. By the end of the 14th century animal representations had disappeared, the pomegranate, the symbol of Christian love, and the pine-apple having gradually supplanted them. These fruits became through the 15th century the characteristic features in the ornamentation of the silken stuffs for both official and domestic dress, and for the ornamentation of churches and houses.

A very interesting development of the pomegranate pattern appears about the end of the 15th century. Broad, ornamented stems take an undulating upward course, and on either side branches bearing roses, blossoms, leaves and little pomegranates, and crowns are disposed. They were the fashion of the Burgundian court in the latter part of the 15th century, where the use of an immense mass of material made the employment of these gigantic patterns possible.

The 16th century saw a great change in pattern designing. The previous evolution having been first of a religious expression, which became more decidedly Christian in meaning, was now succeeded by patterns of a more secular kind, and frequently they possess little or no meaning. This I incline to think was owing to the spread of the Silk industry into France and Flanders, and away from the immediate art and religious influences of Italy. The vase took its place in the pomegranate pattern; then owing to the cut-up forms of dress consequent in changes of fashion, the large designs disappeared, and smaller floral ones, still conventional and fragmentary, took their place.

The Reformation in the early part of the 16th century also influenced pattern designing and especially colouring, to more subdued and less ornate effects. Probably the old designs having so much religious meaning were unhappily discontinued because of their association with the excesses of dogma and ceremonial of the papacy, and pattern designing lost all its dignity, and much of its art perception. The designs obtained and deserved the epithets "baroque" and "rococo," and gradually became distinguished for a superfluity of confused and discordant detail, as may be seen in some of these fabrics of Louis XV. (1715-1774).

For the first time realism in the drawing of floral subjects crept gradually in; it has influenced French designing down to the present day for the worse, and has now become the rule, and not, as in the early part of the 17th century, the exception.

History of French Designing.

Since the days of the Renaissance in Italy and Spain there has been only one great influence in fabric pattern designing, that of the French, and we may begin with it where the

enaissance practically ended, say from about 600. The dignity of the old patterns gradually fell into more or less meaningless and commonplace treatment. I shall illustrate this by typical examples of old fabrics and drawings.

First, the patterns of the time of Henri IV. (1589-1610), the English equivalent of which is the time of Elizabeth (1588-1603).

There are two patterns of her time on the wall: one is a portion of silk from one of her own dresses, sent to me by Mrs. Lomax, of Lichfield, the other a more ceremonial and dignified pattern of a dress which she is wearing at her devotion. It is taken from a frontispiece of a reprint of an ancient Prayer-book, and illustrates the laudable fashion of wearing large patterns. It will be noticed that this pattern is so large that in its length it does not repeat belongs to the patterns of the late Italian Renaissance.

Portion of a Dress Worn by Queen Elizabeth.

The characteristic treatment of the Henri IV. period for stuffs is shown in the drawing of a beautifully-coloured Lyons velvet of this period. This pattern will evidence the disregard for construction and symmetrical arrangement, and with the others, will suffice to show the leading up to the "baroque" character of the rococo period, which culminated in the reign of Louis XV.

Lace manufacture became a very important one in France in the latter half of the 17th century, and the silk designers of Lyons were soon influenced to imitate lace effects in their patterns for brocades, so in many of them one is constantly reminded of Argenteuil lace patterning, and of more recent forms. Lace was at this time much used to enrich the ornamentation of gentlemen's coats and vests, and the imitation of it in the loom was one of easy transition, and its influence continued down to the empire. The culmination of ornamental forms and devices occurred in the reign of Louis XV. Every imaginable idea was brought under requisition and with great skill. Even Chinese ornamentation was largely laid under contribution. Mr. Schulze's words are:—"Flowers and leaves are rendered with the full effect of light and shade, and the natural colours of the flowers are imitated. The rose is used for choice, but fruit also, cherries and plums, in fact, a profuse flora in all possible fantastic forms, together with parts of architecture, cascades, shells, rocks, &c., served as models for the textile patterns of this time."

In the time of Louis XVI. the drawing became still more fanciful and naturalistic, the patterns smaller and accompanied by striped grounds, plain and coloured. Again, in Mr. Schulze's words:—"These small patterns are intermingled with a variety of hunting, fishing, music, and such like symbols; fluttering ribbons, festoons, fruit baskets, &c., appear in the intervening spaces. They are the reflection of a period when ruin was approaching and when no energetic effort was possible. The designs on the textiles are a faithful mirror of the trivial social life of that time." But this state of things did not last for long. Probably in consequence of the excavations at Herculaneum and Pompeii motives were furnished for woven designs, which were taken from the wall paintings of classic antiquity. They bring us, after the desolation which the French Revolution in 1789 spread over art, science, industry, and trade, to the style of the first French Empire, which found its opportunity in the imitation of the antique, or in a new but weaker rennaissance.

Since these periods, the art of textile designing in France has been a play upon them, and in many cases a direct imitation of them. I fear it cannot be said that any healthy influence or originality has resulted during the last 70 years of French designing. In my opinion it has gradually retrograded until, as a rule, it has become burdened with the merest trivialities, commonplace treatments, and eccentricities of form. Large and dignified patterns have, unfortunately, given way to small ones,

for the most part in every conceivable state of art degradation.

In colour the French are always clever, and it must be conceded that, as a nation, they possess great taste in that respect. They make poor designs look attractive.

The more classical forms of decoration of the Empire period are not yet without their baneful influences and admirers; although the taste for the styles of Louis XV. and the Empire is visibly declining in England, under the healthier influences of Anglican effort, and the cultivation of a more imaginative or ideal style of patterning in lieu of the worn-to-death posy-groups of pretty flowers, which a often below the drawing capabilities of schoolgirl.

THE IMPROVEMENTS IN SILK PATTER DESIGNING, COLOURING, AND MANUFA TURE SINCE THE EGERTON EXHIBITIC OF 1890.

It can now no longer be said that we England are deficient in designing powe Whilst decorative design has degenerat abroad, it has, through the advantages offer by South Kensington, and from other i digenous influences in all parts of the countr

TWO DESIGNS FOR SILK PRINTS, BY H.R.H. PRINCESS MARY, DUCHESS OF TECK.

greatly developed, so much so, that our designers have now attained a high degree of excellence, and are sought for from outside the country.

The reasons which actuated me in selecting a date no further back than 1890 from which to review improvements were that it was the year when several of us felt that it was time public attention was called to the fact that the silk industry of this country was fast losing ground, and was threatened with extinction, and that the late Lady Egerton of Tatton, whose interest in the industry chiefly arose from her home being so near Macclesfield, also thought that, before any serious attempt was made by English ladies to advocate the wearing an other uses of British silks, it would be well t have an exhibition of the denominations silk in which our manufacturers excelle and that the exhibition would also be ve useful as recording the then state styles and colourings of home - manufa tured silks.

That exhibition took place, and in spite of number of silks of excellence, there w a consensus of opinion that in many r spects, especially in dress silks, the exhib tion was not a success, and that ladies cou only accord a preference to British silks proportion to such an advancement of art, bo

n design and in colouring, as should show eal progress in the immediate future.

In season and out of season since then the ecessity for artistic progress has been reached to manufacturers, and the result as certainly been surprising. There has been n increase of able designers, and a careful tudy of the history and evolution of pat- erned textiles on all sides. The schools of rt have become more in touch with the silk ndustries in which they are placed, and, as his collection illustrates, British and Irish nanufacturers are no longer nervous or shamed of proclaiming to the world that heir products are worthy the attention of the

Design for a Silk Dress, by Miss Clowes.

wearers and users of silk, and especially of hose of them who are known to possess the ighest culture and taste.

Most fortunately for the industry, that wealthy and powerful body of gentlemen who constitute the channels of distribution have, for he most part given in their patriotic adhesion o the movement for the restoration of British silks to their old places of pride, and are satisfied that there is inherent capacity in our manufacturers to satisfy in the near future, if not entirely at the present moment, their re- quirements; and they are, I know, zealously helping forward the movement with much determination and at some temporary sacrifice.

The collection now before you can speak in more eloquent language than mine, and I desire to say but little about it this afternoon in order that more time may be given for a thorough inspection of the silks now exhibited. It is an object-lesson which will be best taught by self-description. What is, I think, worthy of observation, is a lessening dependence upon continental styles and patterns, and the more English and less French treatment of both patterning and colouring.

The existence of an English school of colouring, which is represented by the leading painters of our time, does not render it neces- sary for any students to go abroad for inspira- tions in that respect; and I think the refined and harmonious colourings which characterise the silks in this collection will convince every one here that the exercise of a purer and higher taste is conspicuously greater to-day than at the exhibition of 1890.

There is also now a happy union of thought and effort between distributor and manufacturer. There are gentlemen of un- questionable taste and artistic perception amongst the distributors who know but little of the technicalities of manufacture, just as there are manufacturers of the greatest possible technical skill who are not equally alive to the artistic progress of the times, and to the taste and requirements of the distributor, and so when both combine to produce a desired effect, the result is much more satisfactory. This may be seen in almost all the exhibits, particularly in the dress silks kindly lent by Messrs. Debenham and Freebody; by Messrs. Lewis and Allenby; by Messrs. Liberty, ever in the van of art pro- gress, and to whom the English and Indian silk industry owes so much; by Mr. Goodyer, whose well-known taste is progressively asserting itself; by Messrs. Warner and Sons, of Spital- fields, leaders of the industry, who have recently entered into a larger scope of production at the extensive works commenced by them at Braintree, in Essex; those old-established Lan- cashire manufacturers, Messrs. Robinson and Millington; by Messrs. McCrae and Co., of Halifax, whose utilisations of Tussur silk place them on a high pedestal of artistic excellence; and by Messrs. Birchenough and Sons and other Macclesfield exhibitors of to-day, as well as the very artistic exhibits of several deco- rators of London and the provinces, who have kindly sent their finely designed silks.

Furniture Silks.

I have many times heard, from ladies

of unquestionable taste, that the designing, colouring, and manufacture of furniture silks in this country leave nothing to be desire but that it is in dress-silks where greater d

Design for Furniture Silk, by T. Wardle, Jun.

velopment and taste is required. That is why the present collection consists chiefly of dress silks, and why manufacturers and their distributing customers have brought together their efforts in this direction.

In the examination of this superb collection, it is for the ladies present to satisfy themselves that a real and progressive improvement is effected, not so much from the so-called æsthetic side, but from a more cultivated art perception, which is producing effects in both design and the wonderful possibilities of combinations of colour which best appeal to that purer taste English ladies are known tc possess, rather than to the extremes anc singularities preferred where that culturec taste is displaced by a love of fancifulness, a so often seen in Paris.

Chiné Silks.

Among the varied collection of patternec silks around this room will be seen some ex tremely interesting fabrics called Chiné o "shadow silks." The old name "Chiné" (from China, or rather the East, where the have been manufactured probably for cen

ries), is applied to a fabric upon which a ıttern has not been woven, but printed upon e warp threads before weaving, after which e weft is shot in and the fabric completed; ving to the impossibility of keeping the warp reads rigidly fixed during both printing and eaving, an indistinctness and softness of outne characteristic of the French impressionist :hool of painting is obtained.

This mode of production may be said to be e fashion of the year, both in dress silks and bbons, and to show how little we need wait r French inspiration, I resolved, about five :ars ago, to revive this old English style. This was in consequence of my visit to India, where in the Rajputana cities I saw much of this method of manufacture and dyeing, the effect being produced by tying the warp before weaving in certain arranged places, as in this example, and then dyeing it. The tied parts escape the dye, whilst the parts not tied receive the intended colour. The tied parts can then be untied, the dyed parts tied, and other colour or colours are given to those parts which were at first tied.

These Indian examples show how effective and artistic the Rajputs are in this description of work. One is a turban tied and dyed in a

Tussur Silk Woven Curtain, Manufactured by H. McCrae & Co.

agonal plaid of a variety of colours, after eaving; the other is a marriage garment ade in this manner, in Baroda, by the warp ıd weft being both tied and dyed before being oven.

This style of work is called in India "Bhanına," from the Hindoo verb "Bhanda," to :. It was by this method of decoration that e old-fashioned Bandana "snuffers" were oduced.

The English effects in Chiné work are otained by block printing on the warp, and ot by the tie and dye process.

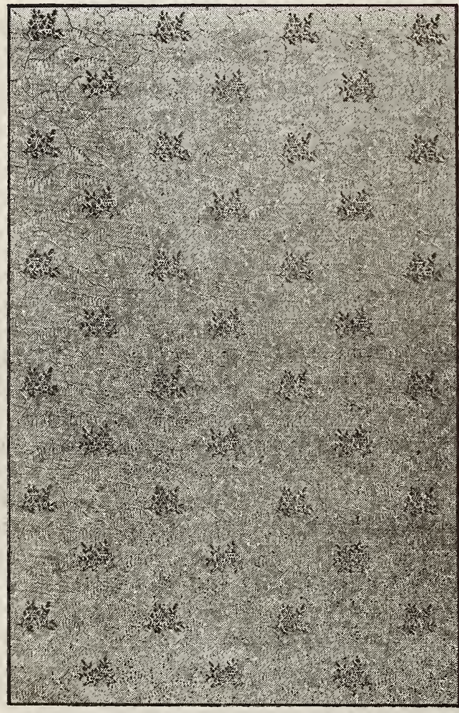
Mr. Goodyer with his well-known taste was the first to endeavour to introduce this revived style to purchasers, amongst whom have been Lyons manufacturers; who, seeing the old style of fifty years ago revived, in which, with Manchester, they so much excelled, set to work in the same direction, and following the English example, have helped to make this style very fashionable this year, both for dress and ribbons.

Silk Waistcoats.

In placing before you this afternoon these

examples of improvements in design, colouring, and manufacture of British silks, I am pleased to be able to add a restored denomination to the collection; one not intended for the use of ladies, but which will, I hope, meet with their admiration and approval. I allude to the samples of silk fabrics for dress waistcoats for the use of gentlemen.

In the preliminary discussions of the Council of the Silk Association, held before the Stafford House Silk Exhibition, it was thought desirable, in the interests of the silk trade, to make an effort to revive the indoor wear of silk vests, leaving to waiters the legacy of the sombre



Patterned Quilting Silk Vesting, woven by T. Warner and Sons.

clothing, which is but the imperfection of taste in gentlemen clad for evening society. My friend, Sir George Birdwood, ever fertile in inventions, moved and carried a resolution, asking His Royal Highness the Prince of Wales to most graciously initiate the old custom of wearing figured-silk waistcoats.

It became my duty, as president of the Association, to place the resolution before the Prince, and to ask His Royal Highness to accede to its prayer. His Royal Highness, with the tact and obligingness which ever characterise him, and always foremost to give a helping hand to all persons and industries deserving of consideration, informed m would be glad to see some examples, and w certainly choose one. The collection shown has been specially manufacture Messrs. Warner and Sons, Spitalfields, fo purpose of submitting them to the Prince. is to be hoped that the fabrics, as well as idea, will commend themselves to His R Highness, and through him to the gentle of England generally; and, let us hope t in due time, the fashion will come round a for coats, breeches, and even stockings of same material. In this, I earnestly ask the aid of your Royal Highness and the la of your all-powerful Association.

I am not scientific enough to define cause of that mental aberration which gentlemen to abjure art in dress, and tak mourning attire for festive occasions; but never too late to mend; and the sooner begin to dress with taste, the sooner will t be satisfied that the art was never meant to monopolised by woman.

Already a change in that direction has in, at any rate, for out-door uses; and bot the hunting-field, and for ordinary wear, fashion of patterned and coloured vests rapidly gaining ground.

I am sure Sir George Birdwood will, at rate, be pleased to see these results of wa coat weaving, unavoidably long delayed they have been. There is a royal preced for this advocacy, for history relates that, 780, Charlemagne sent King Offa, of Merc a present of two waistcoats of silk.

Foreign Cheapness and the Mode Sophistication of Silks by Chemic Weighting.

A question I am most frequently asked ladies is, "But English silks are so mu dearer than French; how do you account it?" I answer, "Until lately, where ha you seen English silk offered as English To this I get the reply, "Oh, but that is t general opinion; everybody says so." No it is only recently that English silks have be offered at all. It has pleased and suited t salesman to make this statement to his cu tomer because he had only foreign silk to offe he must make some excuse, like one made t unthinkingly a short time ago in London. Manchester lady told me she went to a we known silk house to buy silk for a dress. Aft selecting one she thought very pretty, she sai "I suppose it is English?" The salesma

aid, "Oh, dear no, Madam, it is the *best French*!" She said, "Then I won't have it," and walked out of the shop, not because the silk was French, but because of the depreciatory tone in which a prejudice against English silks was expressed.

But some foreign silks *are* cheaper than English, and further, French manufacturers would endorse my statement when I remark that some Swiss silks are cheaper than French ones. This arises from two reasons; first from cheaper labour and longer hours of work in Switzerland, and, secondly, from the very heavy weighting practised there. They make extensive ranges of silks of very light texture, and the chemical weighing of them is carried on to the greatest degree possible of imperfection and deception, as in other silk manufacturing centres on the Continent. No one now but an analytical chemist can estimate the degree. It is prodigious. Here are a few Swiss silks lately purchased in London. They vary in price from 3s. 6d. to 6s. per yard. That they are all weighted I will prove by a ready and easy test.

A pure silk fabric burns somewhat like wool and emits in burning a similar odour to wool or a hot shoe being applied to a horse's hoof. It burns with a flame leaving a black carbonaceous ash. Now weighted silks will not burn in the same way. They contain such a large proportion of metallic salts that the combustion is quite different, as you will see by the following experiments. The metals volatilise without flame, burning brightly. If I were to show you this combustion in the spectroscope, the burning metals would appear in characteristic lines in the spectrum, and they would at once be revealed and identified. I will tell you what elements I find in these silks. In the white and coloured ones I find chiefly tin and phosphorus. In this black silk I find chiefly iron and tin, and in others sometimes lead. This piece of black silk is so heavily charged that it will not burn at all, as you see; the nature of the silk is entirely changed, and it has become an incombustible organo-mineral compound which, when exposed to the light, in a short time becomes, by molecular change, completely rotten, as in this case.

The amount of weighting added to the coloured silks is sufficent to make a pound weigh about 24 oz., and the fibre of the silk is proportionately thickened. In some samples I find each pound of the warp weighted to 24 oz., and the weft to 32 oz. In black silks the weighting is carried to a much greater degree. The weft of this ribbon is weighted to 80 oz. per lb., this black dress silk to 48 oz. per lb., and yet has the appearance and touch of pure silk, whilst this sample of black cordonette, which was given me by a foreign dyer, is weighted to no less than 920 per cent., that is 1 lb. of silk is weighted to 10¼ lbs.

Is it any wonder that such black silks won't wear, or that coloured silks become tender? Is, therefore, a weighted silk cheap? Is it not dear? But if it be remarked that silks are required not to last long nowadays, to that I reply, silks can be weighted in England just in the same manner as abroad if required, and if the price must be brought down to its foreign minimum, resource must be had to thickening the fibre by chemical means, and causing less silk to be used, as on the continent. There is no secret as to how it is done. These metallic salts have a great affinity for silk, and silk has only to be steeped in them to be weighted and then afterwards dyed.

The time has arrived when these facts ought to be generally known, and I have conceived it to be my duty thus publicly to state them. They give an unanswerable explanation of the lowering of prices in foreign-made silks.

Useful as our Merchandise Marks Act is in some respects, it is, unfortunately, powerless to protect us against this gross falsification. It would be a boon to British trade if the Act could be amended so that the amount of weighting could be compulsorily declared, and also that all foreign silks should be declared of foreign make.

The Marking of English Silks.

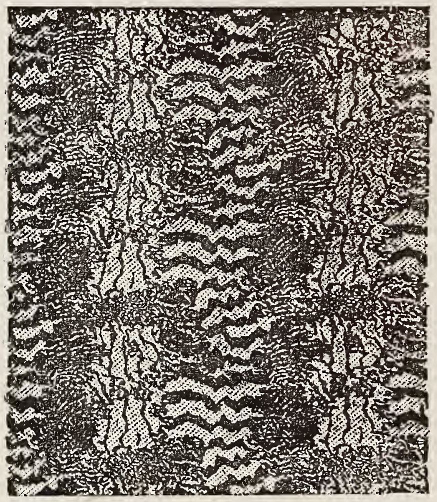
I am now frequently written to by ladies, asking how they can tell when having asked to be shown British silk whether such silk is really home-made.

The only reply I am able to give at present is to ask them to rely upon the honour and truthfulness of distributors of known reputation. But as several ladies of distinction have requested me to urge upon manufacturers to mark on salvedges of silks the words "O British manufacture," I take this opportunity of appealing to the distributors and manufacturers present that this, as far as is practicable, may be done. I have a black silk here marked on the selvedge, at intervals, "English make," which if so used by the foreigner would be a misdemeanour.

Recent Silk Pattern Designs.

I have thought it would be fitting to exhibit

a few designs for silk fabrics, chiefly for dress, by a few pattern designers who aspire to be useful in the ornamentation of British silks. Amongst them Mr. Walter Crane has one design for printed silk for hangings and cushions; Mr. Lewis Day and Mr. Lethaby have one each; Miss Clowes (who was successful in gaining your Royal Highness's approbation at the Stafford House Exhibition, for one design which has since been woven, and is here exhibited for the first time), Mr. Leon Solon (the artistic son of an artistic father), Mr. Rigby, of Leek, Mr. Mawson, and one of my sons, trained to pattern designing, have each contributed a few designs of their own. On the other hand, I have also exhibited some designs done for me in Paris and Lyons for dress silk printing,



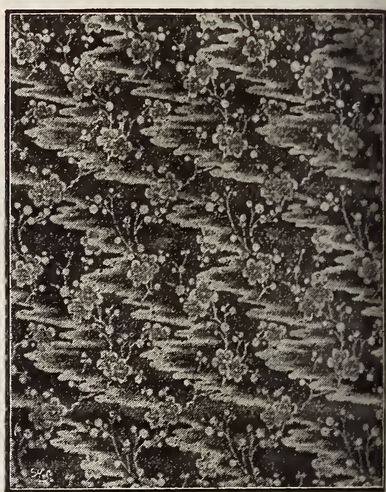
Thetis Damask Silk, Cascade Design.

during the last two years by designers of note.

It is not with a view of disparaging the clever work of our continental neighbours, but to show by comparison that our designers have nothing to fear or to learn from it, seeing that it is rather done to order, for the supposed requirements of fashion, than under the influence of any serious artistic inspiration.

I know I am speaking in the presence of a number of pattern designers—some of world-wide fame. I believe their genius and originality have been but comparatively little availed of by the manufacturers of dress fabrics; too much reliance has been placed upon mere draftsmen's work and patterns from Paris. Now I think I shall hardly be contradicted in stating that, if the manufac e of silk textiles for all purposes is to e permanently lifted into the front rank am the arts and crafts of England, the designs d artistic thoughts of our own professed signers must be sought in preference to th however clever, of other races and natic. We are an insular people, and in art as wel in other matters, we have our own insular ethical ideas, which ought to find their exp sion in all our decorative work, particularly that of dress and for the ornamentation of homes.

We have our own school of painters, a glorious one it is. All who saw extensive works of the painters of seve nations at the Paris Exhibition, in 18 came away deeply impressed with the seren



Cherry Blossom Brocade.

beauty, purity, and, above all, the ethi qualities which pre-eminently prevailed our British pictures, notwithstanding t immense art power of those of our continen art brethren. I heard many persons s "Thank God we have an English school It therefore ought to be so in all ot work in which art can find expressio and if after upwards of 50 years of Victori art training throughout this empire we further need to lean on the inspiration other nations, we cannot too soon begin take a leaf out of the book of our b painters, sculptors, architects, and engrave and rigidly train ourselves to that expressi

* These blocks have been kindly lent by Messrs. Libe and Co, Limited.

a concurrent individuality which so dis-
iguishes these other branches of English art. e do not need to borrow from the modern art oughts of either France or Italy, or from iatic sources, certainly not from the crude and otesque expressions of China or Japan, whose tternings are utterly alien to our thoughts d lives. They represent only themselves, d are foreign even to our artistic Aryan ethren of India, whose ornamentation has much in common with our own.

These imperfect observations lead me to ggest that we should resolutely resolve to courage greater self-reliance; that manu-cturers of silk fabrics should call in the aid those who are devoting themselves to ex-ess in art whatever our insular and aggre-te life causes them to be fit interpreters of. I know of no recent organisations which ve laid so secure a hold upon us as the ts and Crafts Society and the Art orkers' Guild. The exhibitions which have en held by these societies in London ve been eminently successful and stimu-ing. The one now open in Manchester is ng visited by more than 12,000 persons ekly, and contains many admirable art rks in iron and pottery, good decorative work many other kinds, as well as the most istic collection of silk fabrics I have ever seen. e collection of silks in that exhibition, as ll as the beautiful examples in this room, idly lent me for my paper, warrant me, I pe, in having taken for its title, "The im-ovements which have taken place in the de-ning, colouring, and manufacture of British ks since the Egerton Exhibition, 1890."

t has been well said, that Silk is to all other rics what Gold is to other metals and the amond to gems; that it is so—should you seek a visible assertion—I think I may with confi-nce refer you to the artistic clothing of these lls, in the words of Sir Christopher Wren's taph, "Si monumentum requiris, circum-ce."

LIST OF DESIGNS EXHIBITED.

ured Coptic silk, 4th to 5th centuries.

produced Coptic silk, 5th century. Cruciform attern.

,, ,, ,, stripe and herring-bone attern, 5th century.

zantine silk, 6th and 8th centuries.

production of the silk robe in which King Otho of ermany was buried, 10th century (Byzantine esign).

Persian silk figure weaving, 6th century.

Sicilian design, 12th century, (lion and hoopoe).

Saraceno-Sicilian design, 13th century (two stags).

Lucca design, 14th century (eagle and duck).

Sicilian design, 14th century (swan).

Saracenic design, 14th century (bird and boat).

Textile pattern in a picture by Orcagna, 1315 to 1376.

A series of patterns from the robes in pictures in the National Gallery by Caro Crevelli, 1468 to 1493.

Textile pattern in a picture in the National Gallery by Paolo Veronese.

Italian velvet brocade, 15th century.

Italian brocade, 16th century.

Italian fabrics of the 14th, 15th, 16th, 17th, and 18th centuries.

Italian printed cotton, end of 18th century.

Two Henry IV. designs, 1589 to 1610.

Three Louis XIII. fabrics, 1610 to 1643.

Two Louis XIV. fabrics, 1643 to 1715.

Ten Louis XV. fabrics, 1715 to 1774.

Four Louis XVI. fabrics, 1774 to 1792.

Two Empire period fabrics, 1804 to 1814.

Design for printed silk, by Walter Crane.

Four	ditto	ditto	T. Wardle, junior.
One	ditto	ditto	E. G. Reuter.
One	ditto	ditto	Lewis F. Day.
One	ditto	ditto	W. R. Lethaby.
Two	ditto	ditto	Léon Solon.

Four Designs for printed silks, by H.R.H. Princess Mary Adelaide, Duchess of Teck.

Modern naturalistic Chintz designs.

A series of English coloured patterned silks exhibited by Satterfield and Co., Manchester; pure, unweighted.

Six modern English coloured patterned silks, Debenham and Freebody; pure, unweighted.

Modern French patterned silks, in colours, weighted

Weighted Swiss patterned coloured silks.

German black figured silk rotted by heavy weighting.

Four designs for printed silks, by G. R. Rigby, Leek.

Six ditto, ditto, Miss E. M. Clowes.

Twelve modern French designs for dress silks.

Tussur silk patterned curtain, woven by H. C. McCrea and Co., Ltd., Halifax.

Portion of a silk dress formerly worn by Queen Elizabeth.

Twelve silk patterned vestings, manufactured by Messrs. Warner and Sons, London.

Four Poplin vestings, manufactured by Atkinson and Sons, Dublin.

Tussur silk velvet, first pile-fabric of Tussur silk ever made, 1872; suggested by and woven for T. Wardle.

Patterned Chiné silks.

Dress silk designed by Miss E. M. Clowes and manufactured by Messrs. Warner and Sons, London.

Tie and dye or bandhana work, Jeypore.

Bridal garment, tie and dye, or bandhana work, Ulwar.

CATALOGUE OF SILK EXHIBITS LENT TO ILLUSTRATE THE PAPER.

R. Atkinson and Co., Dublin.

Nine examples of Poplin manufactured by them as follows:—

1. Large sunflower in real gold on white ground.
2. Fronds of two varieties of fern in real gold on white ground.
3. Crescent-oriental style of design in threads of real gold on white ground.
4. Large crysanthemum, two blending shades of terra cotta on white ground.
5. Japanese chrysanthemum in nickel grey.
6. Bramble design, two warp brocade in autumn tints.
7. Small rose on black ground.
8. Floral designs in sap green.
9. Small shamrock pattern in black ground.

J. Birchenough and Sons, Park-lane Mills, Macclesfield.

A series of patterned dress silks of various kinds. English designs.

A. Coke and Son, 339, Oxford-street, London, W.

English-made silk parasols and umbrellas; the parasols patterned and plain; designs English.

H. & J. Cooper, 8 and 9, Great Pulteney-street, London, W.

"Sassoon" or Abbeville silk, adapted and coloured by Mr. Manning Cooper, from an old French design.

"Pulteney" brocatelle in resida and gold.

Celadon and silver "Carisbrooke" silk.

Bronze and moss-green "Eastlake" dress siik, original design, from an old Venetian print. Adapted by Mr. Manning Cooper.

Yellow "Eastlake."

Resida-green old English tabaret.

Grey-blue "Katrine" silk, an original design by Mr. Silver.

"Windsor" red silk, reproduction of an old desig

"Abbeville" silk, "Antwerp" green, a mode English design.

"Sassoon" silk, in bright yellow.

"Ambergate."

"Old Rose" old English tabaret.

"Bouquet" silk, reproduction of an old design.

"South Kensington" brocatelle, adaptation old Genoese velvet.

Yellow "Damask" silk, designed by Mr. Cutl Modern English.

S. Courtauld and Co., Ltd., Crê Manufacturers, 19, Aldermanbury, Lo don, E.C.; and Barking, Braintree.

1. A series of chiffons, crêpes, gauzes, a crepons, manufactured by this firm.
2. A design by H.R.H. Princess Mary Adelaid Duchess of Teck, printed on *crêpe de Chi* by Thomas Wardle, Leek.

Debenham and Freebody, 27, Wigmor street, London, W.

1. Specimens of new designs in Spitalfields har woven dress silks. About 10 designs.
2. Examples of power-loom Lancashire dress sil of a similar character to the goods of Swi production.
3. Specimens of *moirés antiques*, *moirés française* satins, and rich plain silks, made in Lanc shire.
4. Specimen of rich Chiné printing of Macclesfie manufacture.

F. B. Goodyer, 155, New Bond-stree London, W.

A series of British-made *chiné*, or shadow silks, two frames, warp-printed by Bernard Wardle.

Howard & Sons, Berners-street, London, W

Series of very fine brocades, damask, brocatelle &c., manufactured in Spitalfields, suitable f dress and upholstery purpose.

Lewis and Allenby, 197, Regent-stree London, W.

A series of British-made patterened dress silks a satins of English designs.

Liberty and Co., Ltd.

A large series of patterned dress silks and sati of English manufacture and design, and and at moderate prices.

H. C. McCrea and Co., Ltd., sil manufacturers, Eastfield Mills, Halifa

1. A series of silks, &c., manufactured by th firm, made in fabrics and designs suitable f dresses, opera cloaks, and upholstery, at pric from 5s. to 8s. per yard.

. A design made in "botany" and silk, of antique, designed by Messrs. Thatcher, Bros., of Kidderminster. (Patten of Tamsay.)

BINSON AND MILLINGTON, Silk Manufacturers, Patricroft, near Manchester; and 2, Milton-buildings, Watling-street, London, E.C.

'our examples of broché taffeta, English designs.
ight examples of broché satin, English designs.
'hese dress silks are of the style, variety, and quality as those imported from Switzerland and Lyons, and are generally of lower cost.

TTERFIELD AND CO., St. Ann's-square, Manchester.

variety of patterned dress silks and satins of recent English designs, and in the newest colourings.

J. WARING AND SONS, LTD., 181, Oxford-street, London, W., and Manchester.

'arious specimens of English made silks for dress and upholstery purposes, including two which are being used for panels and curtains in the drawing-rooms of one of the lady members of the Silk Association.
lso Gothic and other designs.
fine piece of woven tapestry in green and gold, the patterned weft of Tussur silk.

ARNER AND SONS, Spitalfields; 9, Newgate-street, London, E.C., and Braintree, Essex.

. Brocades, Damasks, brocatelles, for furniture, wall-hangings, curtains, &c., in various, styles, English, Italian, French, Adams, &c.
. A series of dress silks and manufactured samples or colour sheet.
. Figured velvets, patterns, silks for the proposed new evening dress waistcoats, in various colours and designs.
. Twelve quilted silks for the proposed new even- dress waistcoats, in various colours and designs.

DISCUSSION.

Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., said deeply regretted that he had not the ability to do tice to the great services rendered by Mr. Wardle the reviving silk industry of the United Kingdom; he had all the will, and it was moreover duty to accept every opportunity of bearing his rsonal testimony to their value. The two definite ies of researches which had given Mr. Wardle the -eminence he enjoyed in his business as a dyer were dertaken for the India-office, and under the direction the department with which he (Sir George Birdod) was connected. Mr. Wardle's investigation the dyes of India led at once to those improvements in artistic dyeing in this country to which Mr. Lasenby Liberty had given such charming effect, and associated with his name throughout the world; while his investigation of the "tussur" and other wild silks of India has been productive of equal industrial, although less generally known benefits. Mr. Wardle taught us how to remove the resinous coating of "tussur" silk, which had hitherto prevented it from taking many of the choicest dyes, and by so doing to render it capable of taking all the dyes taken by mulberry silk, and therefore merchantable for nearly every purpose for which mulberry silk is merchantable. One result has been that, whereas in 1878 not a single pound of "tussur" was used by the silk manufacturers of Europe, now the weekly consumption of "tussur" at Lyons alone averages 16,000 lbs.: and in addition to this, "tussur" is also being used in Switzerland, Germany, England, and America in increasing quantities. Unfortunately China has taken far greater advantage of Mr. Wardle's labours in this connection than India. Again, with the first supply of "tussur" sent by him (Sir George Birdwood) to Mr. Wardle in 1872, the latter had a piece of velvet made at Crefeld (No. 95 on the wall), and it is no exaggeration to say that this sample of tussur-velvet first suggested the substitution of "tussur" for mohair in the manufacture of "seal-cloth," and laid the foundation of that opulent velvet trade subsequently developed by Messrs. Lister and Co., of Manningham, and other Yorkshire manufacturers, of seal-cloth. These two researches, begun, continued, and ended under the auspices of the India-office, are great and beneficent achievements, and if others have reaped the substantial profits arising therefrom, at least the glory of them is all Mr. Wardle's own. But Mr. Wardle's greatest work, when we consider the almost insuperable difficulties that beset its initiation, and the immense consequences—in the revival of what was once a great national industry—that are sure to follow from it if persevered with in the same public spirit with which he undertook it, his greatest work by far has been the organisation of the National Silk Association of Great Britain and Ireland. It has already succeeded beyond all expectation, for at this moment most of our silk manufacturers, and all those who produce silk stuffs of the best artistic quality, have more orders on their hands than they can execute with their present plant; a fact of the the happiest significance for the future of the industry. But the surest augury of Mr. Wardle's ultimate success is to be found in the fact of his having secured for the Silk Association the cordial co-operation of the ladies of the United Kingdom. There is an old national proverb, "England is the Paradise of women;" and because, as John Ray explains ["Collection of Proverbs," 1672: 2nd ed. 1678], there is no other country where they more thoroughly rule the roost, "so much so, that were a bridge cast across the Straits of Calais, all the women of the world would come over it hither." And of this very subject of

silk, a contemporary of Ray's, the anonymous author of "Britannia Languens" [1680]—it has always been 'anguishing Britain," ever since these islands first

"Arose from out the azure main"—

pertinently observes that, although we formerly used ut little of silk in town or country, now with the growth of our "national Gaudery," it has come more and more into mode, for our women will have it so, and our men always "follow their humours." He speaks of it as used not only for "the common wear," but for bedding, hangings, carpets, and coach-linings. Passing to detailed criticism of the paper, he (Sir George Birdwood) entirely concurred in Mr. Wardle's condemnation of the influence of Japanese art on English decorative designs. He was aware of being deeply prejudiced against the conventional applied art of Japan; but he spoke now not from his prejudice, but from the facts of history. The vogue of Japanese art in France during the reign of Louis XIV. developed the rococo style of art which prevailed throughout Europe during the reign of Louis XV.; and the revived influence of Japanese art in Europe since the publication, in 1863, of Sir Rutherford Alcock's "Japan," is the obvious cause of the degradation, and he would say depravity, of taste which has obtruded itself in so many departments of English artistic activity in recent years, and which, it would be as well to emphasise, in connection with Mr. Wardle's paper, was particularly apparent, and repellent, in the aggravated absurdities of the female fashions of the day. Mr. Wardle was always mourning over the abolition, in 1860, of the 15 per cent. *ad valorem* duty on foreign silks. But it was now too late for Englishmen to denounce free trade, which was the chief corner-stone of the British Empire as it had been built up during the glorious and beneficent reign of Queen Victoria. English free trade had not only made the British Empire as it existed, but modern Italy and Egypt, and India and China, and Japan, and had immensely profited France, and Germany, and America. English free trade had in short made Britain the whole world, and the whole world—

"All that the Ocean graspes in his long armes"—

Britain; and all this would gradually become belittled, and would ultimately have to be surrendered, if we ever reverted to protection. Of course free trade to be really effective must be thoroughgoing and self-consistent. The very basis of free trade was free labour, and if we in this country ever drifted into protected labour, one of its first results would be a reversion to protected trade. As for our silk manufacture, free trade had had nothing to do with its decline, which, like the decline of British agriculture, and other of our national industries, was entirely due to protection; relying on which, we had neglected our silk manufacture in every way; and the strain and stress put upon it by the abolition of the 15 per cent. duty on foreign silks, in 1860, just came in time to save it from utter destruction. The manufacture of silken stuffs is as natural to these islands as to France, and if its resuscitation here i be successful and enduring, it must not again bec dependent on any artificial bolstering up with so-ca "protective duties," but be manfully sustained or own merits, technical and artistic. No; the causes of the decline of our silk manufacture si 1860, as of so many of our manufactures, are to traced to our love of ease and dislike of risks changes, insular faults, further developed by our pendence on protection, which have blinded us to signs of industrial progress and economic revoluti and rendered us dilatory in adapting ourselves to new conditions of international life, until one natic industry after another seems almost on the poin extinction. It is incredible, but it is the fact t many of our silk manufacturers have never visited great centres of silk manufacture on the contine such as Crefeld and Lyons. The faults of our ca talist manufacturers are found intensified in artisans and labourers of all classes; the healthi bravest, and by nature the most capable wo men in the world, but the most ignorant, prejudic and perverse, and most thriftless, disorderly, brutal;* and ever the easy prey of any plausi panacea proposed for the imagined protection of tl class interests. Thus we read this very week of president of the Yorkshire Miners' Association deavouring to oppose the spread of the use machinery in mines. Then there is our ineradica hypocrisy, which, as it deceives ourselves only, fatal. Here in this very paper is Mr. War looking to heaven for differential favours because would make believe that we do not gum or otherw weight our silks, as do other nations, even th Frenchmen and Germans. Why the very "mal weight" used in Germany and France was origina an English invention, and is, I believe, still cal "London Black." Charles I. issued a proclamati against our manufacturers using it, and other simi fraudulent sizes, for the weighting of silk; but strong was the interest of the nation in their u that the proclamation had to be immediately wi drawn. Of all crafts honesty is the master craft, a much of its mastery lies in believing others to be honest as ourselves. Finally, a special obstacle to artistic improvement of our silk manufactures is far too slavish subservience of our ladies to the fashic imposed on them by dressmakers who know o their trade, and nothing of their truly noble a of which the first principle, alike subjective [movin and objective [determining], is respect for the thro of modesty [Αισχυνης θρόνου τιμη]. Look at female fashions set for the coming summer. Th are a disgrace to the understanding and the ta of any one of the most elementary education a culture; and an insult to that intuitive reticer of carriage and demeanour, which is one of most attractive charms of English women. The p

* Compare Sir Francis Hasting Doyle's "The Private the Buffs," Sir Henry Yule's "The Birkenhead," and J. Mill's "Political Economy," vol. ii.

ence of such outrageous fashions is calculated to manently impair not only the artistic quality of sumptuary industries, but the ethical quality of entire social life. Perverted taste in the end ins perverted morality. Shakespear says of nen's eyes, in language as true as it is beau-l:—

"They are the books, the arts, the Academes,
That shew, contain, and nourish all the world;"

l be sure if your eyes be turned to evil, not only l our silk and other sumptuary manufactures suffer, our whole body politic will be full of darkness.

Mr. M. M. Bhownaggree, said he could scarcely ceed in a strain of criticism in the learned style Sir George Birdwood on the many interesting nts suggested by the paper, but he could bear will- testimony to the great advantage of the efforts de to revive the home industry in silk. He had n for many years a member of the Silk Associa-n over which Mr. Wardle presided, and had nly watched and taken interest in the various vements inaugurated by it under the auspices her Royal Highness the Duchess of Teck, o was in the chair, and many other influential lies; and he could not but think that the neficial effects of their operations would be -reaching if persevered in. At a time when pression in industrial—as in many other—lines was parent on all sides, such efforts were most laud-le, and to him, personally, they appealed with ecial force, from the fact that he had witnessed silk industry of Surat and many other places in lia die out; and more recently had he observed h distress the once famous silk industry of Bethnal-en and Spitalfields nearly abandoned. There was ime when deftly woven pieces of genuine silk were prized possessions in the rich families in various ts of India. These had given way to the flimsy ductions of France and Germany. Consequently, ether, as regards India, or nearer home, as regards thnal-green, he felt sure that the work performed the Silk Association was highly patriotic and eficial to the subjects of the British Empire. ch instruction as was afforded by the paper which y had listened to did much to foster the aims of Association, and he (Mr. Bhownaggree) would e that opportunity of wishing it success in its le purpose.

A vote of thanks to Mr. Wardle for his paper s carried unanimously.

Mr. Francis Cobb said he had the honour of posing a hearty vote of thanks to her Royal hness the Duchess of Teck for taking the ir. He felt sure that this would be carried h one accord, and in doing so they would k how beneficial it was to the silk trade to e these important questions ventilated as they could be at meetings of that kind, so that they might realise what was going on in our own country, and what vast strides were being made in the silk trade. He could remember the time when, after the removal of the protective duty of 15 per cent., it was thought, as Mr. Wardle said, that the silk trade would leave the country, and no doubt silk manufacturers had drifted into a sleepy condition at that time; the machinery and styles were not up to what they were in many other places. Happily the Association, of which her Royal Highness was President, had given such an impetus to the trade, that it pushed it on to success, and no doubt they would soon be in a position not only to compete with other countries, but to take the lead. Some years ago England lost to a great extent the supply of the large colonies, both east and west, especially Australia. The fashion there, following the fashion of this country, was to get continental silks, which were all called French, but he believed now we should recover that; and for that they had to a great extent to thank the steps which her Royal Highness had taken to bring that industry back to this country.

The vote of thanks was carried unanimously.

Miscellaneous.

THE COMMERCE IN COTTON-SEED OIL.

The rapidity with which the commerce in cotton-seed oil has spread from America to this country, and to other parts of Europe, is a fact that is well known to all, but to get anything like details of the cotton-seed industry in America at the present day we must turn to a recent report of the British Consul at Charleston, who draws attention to the commencement of the trade just after the close of the American Civil War in 1865, and compares it with its present condition as one of the most important of the agricultural industries of the cotton-producing districts of America. In 1867, there were only four cotton-seed oil mills in the United States, while at the present time there are 253 such mills throughout the country, 27 of them being situated in South Carolina.

It is said to be "somewhat noteworthy that throughout the development of the business there was a constant feeling of apprehension on the part of those most interested that it would be overdone, but each year seems but to add greater stability to the industry, and lower prices appear to be offset by a steady increasing demand, and a wider range of markets for the various products of the cotton seed. The refined oil is rapidly coming into favour for cooking uses, both in its natural condition and compounded with other preparations now on the market. The oil itself is a sweet, wholesome, and fine vegetable oil, and is regarded as far preferable by many

persons to hogs' grease for kitchen use. In the early history of the oil business prices were 50 to 60 cents per gallon, and sales have been made at a maximum of 60 cents per gallon within the past two or three years, but, on the other hand, since that time prices have gone as low as 20 cents per gallon. The 27 mills now in operation in South Carolina have a capital of over 1,000,000 dollars, and the quantity of seed crushed by them last year was about 75,000 tons, valued at 800,000 dollars, producing 60,000 barrels of oil, 26,000 tons of cotton-seed meal, 5,000 bales of linters, and 25,000 tons of hulls. The oil is sold in the northern and western markets, and is largely used in the manufacture of compound lard and other food products. Several years ago, part of the cotton-seed meal produced in this State was exported to foreign countries, but during the last two years it has all been consumed at home, much of it being used by farmers as a manure, either by direct application of the meal to the land, or by composting it with phosphates. The fertiliser companies also consume a certain portion, and, in addition, considerable quantities are used as a food for fattening cattle and stocks, for which it has been found to be well suited when mixed with the cotton-seed hulls. The hulls were formerly used as fuel, but the increasing demand for them for cattle food has made them too valuable to be used any longer in that way, and there is now little or no consumption for fuel purposes.

The prices for cotton oil at the close of the season was low, quotations being reported at only 20 cents for oil per gallon. The price of seed varies in proportion to the value of oil; indeed, it is regulated by it, and the mills have uniformly paid for seed a fair price, such as would be justified by the value of the product. It has been estimated that the average price paid for seed last year added nearly 1 cent per pound to the total value of the cotton crop in the United States.

THE BREWING SCHOOL OF GHENT.

The latest statistics show that the total quantity of beer brewed in Belgium is estimated at about 300 million gallons annually, and the revenue derived by the Government, £600,000. Considering the interests involved in the manufacture, sale, and consumption of beer, it is natural that the country at large should take measures to protect all parties. On the one hand, the Government is desirous of securing its full revenue from this source; on the other, the brewers are anxious to avoid excessive taxation and to reduce their expenses, while the public is interested in securing for the least money, as its national beverage, the best and most wholesome product possible. It is consequently not surprising to find that the Belgians are reducing the brewing of beer to scientific principles. The public demands that those who are engaged in this trade should be educated in those subjects which especially appertain to and affect this vocation. The United States Consul at Ghent, his last report, says that two professional school brewing have been established in Belgium—one Louvain, attached to the university of that city, the other at Ghent, which, however, is enti independent of the university. Of the 2,875 Belg breweries reported in activity during 1893, not l than 1,000 are situated in the two Flemish provin of which Ghent is the chief city. The brewing sch of Ghent is considerably larger and more import than its competitor. It was founded in 1886 by Brewers' Association of Ghent, in order to aff brewers and their sons the opportunity to study process of brewing as a science. It is support by that Association, by the Belgian Natio Brewers' Association, by the Government, by t province of East Flanders, and by the city of Ghe Brewers and superintendents of breweries are th afforded an opportunity of making practical applic tion of the theoretical knowledge which they m possess. Gratuitous instruction is also given to fo men and other brewery *employés*. The courses are arranged that brewers or their workmen may co plete their studies in one year without any inte ference with their daily occupation. The school governed by a director and a committee of t Brewers' Association of Ghent. The director al acts as president. The instructors consist of sev professors, teaching the following general subjects:- Theoretical brewing; scientific study of brewing practical instruction in brewing; book-keeping analytical, general, and applied chemistry; chemist of fermentation, of bacteriology, and of industri biological chemistry; mechanics; steam-engines ar boilers; general and industrial physiology; legisl tion affecting brewing; commercial law; industri drawing and polarimetric analyses. Three courses instruction are offered, viz., (1) a gratuitous course six months for brewery workmen, (2) a profession course of one year, with an examination for th diploma of master brewer, and (3) an advance course of two years, with an examination for th diploma of brewing engineer. In the first cours not only is the instruction given free, but all book instruments, and materials necessary are also fu nished without expense to the student. The tuitic fee for the second course is £20 per annum; whi for the third course it is only £14. When tw brothers follow the same course, a reduction 25 per cent. is made; even a still less sum received in the case of a poor but exceptional bright student. At the present time there are 7 pay students enrolled, 46 are in the second cour and 25 in the third. The course of instruction is follows:—For the free course, instruction in brev ing, practical course in the operation of stean engines and in the technology of apparatus employe in breweries, practical work at a brewery, and visi to neighbouring breweries. For the profession course, and for the first year in the more advance course, theoretical and practical brewing, mechanic

ıology of the apparatus employed in breweries, ents of bacteriology, legislation affecting brew- commercial law, book-keeping, industrial draw- practical exercises in bacteriology, practical :ises in brewing, chemical manipulations, and s to neighbouring breweries. All students are ired to regularly attend the chemical, brewing, bacteriological laboratories. They are further ged to be employed at practical work at some very in Ghent, to be designated by the faculty. vers and their sons may work in their own olishment. The instruction for the second year he more advanced course includes scientific ies in brewing; analytical, general, applied, biological chemistry; industrial physics, steam ers and engines, microscopy and polarimetry, strial drawing, practical exercises in brewing, ytical chemistry, and biology.

'HE MEERSCHAUM MINES OF ASIA MINOR.

ıe meerschaum mines of Eski - Chéhir, an ortant station on the railway running be- n Angora and Ismidt, have a world- reputation, and the finest deposits of the le, known in commerce as meerschaum, are d at a distance of about eighteen miles to the h-east of the town of Eski-Chéhir. The gian Consul at Constantinople says that it would extremely difficult to accurately determine the nt of the places where deposits of meerschaum found. That the area is a very extended one is wn by the number of mines at present existing, e that are beginning to be sunk, and by the ance separating them. The principal districts are etdja-Odjaghi and Kemikdja-Odjaghi, and are ted at a distance of about three leagues from one her. The meerschaum is extracted in the same as coal. Pits are sunk with a depth varying veen eight and forty yards, and as soon as the ers strike the vein horizontal galleries are formed, h extend for a considerable distance. Some of e galleries accommodate as many as forty ers. The stone, on leaving the mine, is called *tache*; it is so soft that it can be easily worked with a knife. Its colour is white, with a slight w tinge. The block is covered with a red vege- e earth of about two inches in thickness. The ks of meerschaum in this state are immediately hased by the merchants, who attend the various es and superintend the operations. These pur- es are made neither by weight nor by legal measure, according to a quantity determined approxi- ely by established usage. This is called "three s full" (*utch dolon tchonval*) or *bir araba usson*, that is to say the quantity that can be ed in a small farm cart. The price of this sure varies between 500 and 3,000 piastres accord- o the quality. The rough blocks (*hamtache*) are dried and subjected to certain treatment before being carried to Eski-Chéhir. The size of these blocks is very varied. Some are not larger than an ordinary nut, and some exceed a cubic foot in size. Their shape is also very irregular. The rarest and those which are most prized are those whose appear- ance is the most regular and the size greatest. The labour entailed in getting these blocks in the proper condition for exportation is both tedious and costly. First of all the clayey earth which adheres to them is removed, and they are then subjected to a process of drying. In summer this operation is a very simple one, it being only necessary to expose the blocks in the sun for five or six days. In winter they must be shut up in apartments where the temperature is con- stantly rising, and here they are only completely dried in from eight to ten days. The blocks when perfectly dried are subjected to a second cleaning, after which they are polished by means of wax. This operation of polishing is sometimes affected by means of a coarse cloth, a product of the country, called *chaïac*. The last operation is one which requires a great deal of care and attention, and is a very delicate one to perform. It consists in placing the pieces of meerschaum into boxes. To avoid shock or rubbing against one another, or against the side of the box, a quantity of cotton is arranged between the pieces of meerschaum and also between them and the sides of the box. It is in this state that the meerschaum is brought to Europe. Each box contains stone of one quality, and the size of the boxes varies accord- ing to class. The largest quantity of Eski-Chéhir meerschaum is forwarded to Vienna, which is the centre of the trade, although some of the best blocks of the first quality are generally sent to Paris. A party of Americans have recently been inspecting the meerschaum mines of Eski-Chéhir with a view of obtaining direct for the United States market, and so establishing a new industry there, the meerschaum exactly as it is forwarded to Vienna. In this state it would enter free of duty in the United States, while the worked material is subject to a customs duty of 75 per cent. The average export is estimated at about 8,000 or 10,000 boxes annually. The Turkish Government impose various duties on this article, amounting in the aggregate to 37 per cent. Other deposits of meerschaum are found at Kiltshich, about two leagues from Koniah, terminal point of the railway line from Eski-Chéhir, now in course of construction. The richest and best known of the meerschaum mines are still, as regards the manner of their working, in a very primitive con- dition. It is said that the meerschaum deposits of the environs of Sebastopol, of Coffa, in the Crimea; of Egrebos, in the island of Negroponte; and of Corinth cannot compare with those of Asia Minor, both as regards quantity and the purity of quality of the meerschaum itself. M. de Posson says that if an experienced company would only obtain the con- cession of all the meerschaum mines of Asia Minor, it would be most advantageous to the company and also to the Ottoman Government.

THE CULTIVATION OF THE COLOCYNTH.

The colocynth, or bitter apple, which provides in its dry pulp a well-known purgative medicine, grows abundantly on the maritime plain that lies between Palestine and the eastern shore of the Mediterranean. It is found from below the city of Gaza on the south, to the base of Mount Carmel on the north. Consul Wallace, of Jerusalem, says that the dwellers along this plain pay little attention to the plant, and spend neither time nor labour in its cultivation. It grows without cultivation, the soil and climatic conditions producing it without the help of the husbandman. With some attention the plant would undoubtedly bear a larger and richer fruit—richer in that pulp which makes the colocynth valuable. But there is no object in thus improving the plant and its yield, as Nature alone now supplies far more than the natives can find a market for. The soil of this maritime plain is a light brown loam, very rich, and almost without a stone. In places where the loam has been mixed with sand the colocynth plant seem to thrive best. Very little rain falls on parts of this plain, but the plant does not suffer from this lack of moisture. The climate is warm all the year round and during the summer months the heat is intense, so that the conditions necessary for the successful raising of the colocynth seem to be a good soil somewhat sandy, a warm climate, and little moisture. The plant itself resembles a common cucumber, but its fruit is globular, about the size of an orange, and of a light brown colour. Its rind is smooth, thin, and parchment-like. It is known as the Turkish colocynth, and is superior to the Spanish and Morocco varieties in the amount of pulp its fruit contains. The pulp constitutes 25 per cent. of the fruit, and the rind and seeds are valueless. The fallaheen, or peasants, gather the fruit in July and August, before it is ripe. It is sold to Jaffa dealers, who peel it and dry the pulp in the sun: it is then moulded into irregular small balls, packed in boxes, and shipped chiefly to England. The average annual shipping from Jaffa is 20,000 pounds, though the shipment in 1894 amounted to only 6,000 pounds. This quantity could be increased indefinitely if there were more demand for it and a price were paid that would make it an inducement for the peasants to gather and prepare it. The price now paid for the colocynth pulp, prepared, packed for shipment, and delivered on board the steamer in the port of Jaffa, is about fifteen pence a pound.

General Notes.

Paris Exhibition of Lithography.—Information has been received from the Foreign-office, through the Science and Art Department, that an International Exhibition, to commemorate the centenary of the invention of lithography, will be opened at Paris on the 15th August, and will continue u[ntil] the 30th November. The Exhibition is under [the] patronage of the Minister of Public Instruction a[nd] of the Minister of Commerce. There will be [six] Divisions—Group 1, Historical; 2, Artistic Lit[ho]graphy; 3, Scientific Lithography; 4, Industr[ial] Lithography; 5, Lithographic Materials (ston[es,] paper, inks, presses, &c.); 6, Lithographic Ind[us]tries. The address of the Committee of Directors [is] 4, Rue du Bouloi, Paris.

MEETINGS FOR THE ENSUING WEE[K].

Tuesday, June 4...Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Ray Lankester, "Thirty Yea[rs'] Progress in Biological Science." (Lecture IV.)

Wednesday, June 5...Geological, Burlington-house, W., [8] p.m.
United Service Institution, Whitehall-place, S.W., [3] p.m. Admiral Colomb, "The Future of the T[or]pedo."
Photographic Club, Anderton's Hotel, Fleet-stre[et,] E.C., 8 p.m. Mr. E. J. Wall, "The Use [of] Coloured Screens in Photography; Commerc[ial] Isochromatic Screens and Plates, and their Use[s]."
Archæological Association, 32, Sackville-street, W., 8 p.m.
Obstetrical, 20, Hanover-square, W., 8 p.m.

Thursday, June 6...Linnean, Burlington-house, W., 8 p[.m.] 1. Mr. George West, "A New *Distomum*." [2.] Madame van der Bosse, "A New Genus [of] Siphonean Algæ, *Pseudoconium*." 3. Mr. [G.] Vaughan Jennings, "The True Nature [of] *Mobuisispongia parasitica*." 4. Mr. A. Vaug[han] Jennings, "A New Genus of Foraminife[ra,] *Raphidoscene Condea*."
Chemical, Burlington-house, W., 8 p.m. 1. [Dr.] Gladstone and Mr. W. Hibbert, "The Molecu[lar] Refractions of Dissolved Salts and Acids." [2.] Mr. Spencer Pickering, "A Comparison of so[me] Properties of Acetic Acid and its Chlora[and] Bromo Derivatives." 3. Mr. F. D. Chattaw[ay,] "Dinaphthyl and its Quinones."
Royal Institution, Albemarle-street, W., 3 p[.m.] Dr. W. Huggins, "The Instruments and Meth[ods] of Spectroscopic Astronomy." (Lecture III.)

Friday, June 7...Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting, 9 p.m. Prof. Alf[red] Cornu, "Phénomènes Physiques des Hau[tes] Regions de l'Atmosphère."
Geologists' Association, University College, W.C., 8 p.m. Mr. Nicol Brown, "The Necessity [of] Competent Geological Surveys of Gold Mines."
Philological, University College, W.C., 8 p.m.
Queckett Microscopical Club, 20, Hanover-squa[re,] W.C., 8 p.m.

Saturday, June 8...Sanitary Institute, 74a, Margaret-stre[et,] W., 2 p.m. Prof. W. H. Corfield, "Water Supp[ly,] Drinking Water, and Pollution of Water."
Royal Institution, Albemarle-street, W., 3 p.[m.] Prof. Edward Dowden, "Elizabethan Literatur[e.]" (Lecture II.—"The Masque.")

Correction.—Page 612, the paragraphs in M[r.] Charleton's paper commencing "The princip[al] mining companies" and "Le Société Nickel," ha[ve] been misplaced, and should come on page 611, at t[he] end of the paragraphs on "New Caledonia."

[J]ournal of the Society of Arts.

No. 2,220. Vol. XLIII.

FRIDAY, JUNE 7, 1895.

[Al]l communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take [pl]ace at the South Kensington Museum (by [p]ermission of the Lords of the Committee of [C]ouncil on Education), on Wednesday, June [1]9th.

The reception will be held by Major-General [S]ir John Donnelly, K.C.B., Chairman, and [th]e Members of the Council of the Society, [fr]om 9 to 10 p.m.

Each member is entitled to a card for him[s]elf, which will not be transferable, and a [c]ard for a lady. In addition each member [w]ill be able to purchase two transferable [ti]ckets, the price of which will be 5s. [e]ach up to the day of the *conversazione*; [o]n that day the price will be raised to [7]s. 6d. It is requested that members requiring [th]ese additional tickets will make early appli[c]ation for them. Every application must be [a]ccompanied by a remittance.

Promenade Concerts will be given in the [N]orth Court and in the Textiles Court of the [M]useum, commencing at 9 15 p.m.

A Glee and Madrigal Concert will be given [a]t intervals in the Lecture Theatre, com[m]encing at 9.30 p.m.

A Vocal and Instrument Concert will be [g]iven in one of the galleries of the Museum, [c]ommencing at 9.30 p.m.

Light refreshments (tea, coffee, ices, claret [c]up, &c.) will be supplied at the usual Re[f]reshment Buffets in the Central Corridor of [t]he Museum.

As the old Museum quadrangle is now covered in, none of the entertainment will be in the open air.

Further particulars as to the musical and other arrangements will be given in the programme, which will be distributed on the evening.

Cards of invitation are now in course of issue.

TECHNICAL INSTRUCTION CONFERENCE.

The following letter has been addressed to representatives of Technical Education Committees, and others interested in the subject:—

"Society of Arts,
"Adelphi, London, W.C.
"*May*, 1895.

"Sir,—It has been suggested to the Council of this Society that a useful purpose would be served if the Society were to afford to those who are interested in Technical Education in different parts of the country an opportunity of meeting together, and discussing the measures which the Society might take with a view to enlarge the scope of its present action in this matter, and thus aid local authorities in giving effect to recent legislation on the subject.

"There appears to be a lack of a central organisation which might deal especially with such questions as the examination and inspection of classes. In spite of the valuable work which has been done by the City and Guilds of London Institute, and by other bodies, it is only in a portion of the subjects sanctioned as subjects of technical instruction that examinations are held. The wide field of agriculture and home industries is untouched; while no means are provided for anything like a general system of inspection which local authorities may call to their aid should they desire to do so.

"There are also other points with regard to which common action would be desirable, and the Council of the Society have, therefore, determined to hold a Conference of Representatives of the Technical Instruction Committees of the various County Councils and others, with the view of eliciting their views on the subject. It is proposed to hold this Conference on the 20th of June next, and to invite to it the Chairmen of the Technical Instruction Committees, or other representatives who may be delegated by such Committees, and their Directors or Organising Secretaries.

"I shall be glad if you will let me know whether you can yourself attend the meeting, and also whether your County Council will depute any members of its Technical Instruction Committee to attend.

"I have the honour to be, Sir,
"Your obedient Servant,
"Henry Trueman Wood,
"*Secretary.*"

PRIZES FOR PHOTOGRAVURES.

Report of the Committee.

The Committee are glad to be able to report a successful result of the offer by the Society of prizes for the best Photogravure plates and

negatives. The following were the prizes offered:—

(1) A Prize of Twenty Pounds (with a Silver Medal) or a Gold Medal for the best reproduction of a selected picture by a Photogravure process.

(2) A Prize of Ten Pounds and a Silver Medal for the best Photographic Negative of a selected picture, suitable for reproduction by a Photogravure process.

Competitors were required to send in a reproduction of Mulready's picture, "Choosing the Wedding Gown," now in the South Kensington Museum, this picture having been selected on account of the difficulties it presents to reproduction by purely photographic and mechanical means. It contains a great variety of colours with strong contrasts, and many of the tints are precisely those of which it is more difficult to render the values in light and shade by photography.

The Committee demanded, for prize No. 1, a plate produced without any handwork at all, and for prize No. 2 an untouched negative. They quite recognised the fact that the best results have hitherto not been produced without handwork, but their object was to ascertain how far a satisfactory reproduction of an artist's work could be obtained without the intervention of another and different personality, and they think that their demand has been justified by the result.

There were in all 19 competitors, of whom five entered only for prize No. 2.

The following Committee was nominated by the Council to draw up the conditions of the award, and to judge the works sent in:—Major-General Sir John Donnelly, K.C.B., Chairman of the Council; Sir Frederic Leighton, Bart., P.R.A., H. T. Wells, R.A., E. J. Poynter, R.A., Francis Cobb, Thomas Armstrong, Captain W. de W. Abney, C.B., F.R.S., and Sir Henry Trueman Wood, Secretary. Sir Frederic Leighton and Mr. Poynter were not able to take part in the adjudication.

The Committee were greatly impressed by the excellence of much of the work sent in, a great deal of which was quite up to a standard that might have justified the award of the prize. In judging of the relative merits of the pictures they laid especial stress on the truthful rendering of the colour values, and they consider that the selected competitors have been very successful in this difficult task.

The Committee recommend that the pri[ze] of a Gold Medal (or Twenty Pounds and [a] Silver Medal) be awarded to A. Ernest Smit[h], 5, Coldershaw-road, Ealing Dean, W.

They also consider the work sent in by A. S[.] Handford, 3, Coldershaw-road, Ealing Dea[n], W., is worthy of high commendation.

They recommend that the prize of a Silv[er] Medal and Ten Pounds be awarded to Th[e] Swan Engraving Company, 116, Charing-cros[s]-road, W.C., for the negative sent in by them.

The Committee consider that the Society i[s] greatly indebted to the Science and Art De[-]partment, which granted facilities for th[e] copying of the picture, and also to the official[s] of the Department upon whom, in carryin[g] out the necessary arrangements, a good dea[l] of trouble was thrown.

The Committee think it desirable that th[e] works sent in should be exhibited for a shor[t] time in the Society's house.

HENRY TRUEMAN WOOD,
Secretary.

The works will be on view at the House o[f] the Society of Arts, John-street, Adelphi, fro[m] Monday, June 10 to Saturday, June 15. Ad[-]mission by visiting card.

Proceedings of the Society[.]

FOREIGN AND COLONIAL SECTION[.]

Tuesday, May 21; SIR OWEN ROBERTS[,] M.A., D.C.L., in the chair.

The paper read was—

COMMERCIAL EDUCATION IN BELGIUM.

BY WILLIAM LAYTON

(Professor at the "Institut Supérieur de Commerce" a[t] Antwerp).

It is not so very long ago that, in England[,] there were only three classes of schools for th[e] education of youth. The public schools, suc[h] as Eton, Harrow, Charterhouse, &c., for th[e] sons of the upper classes; private proprietar[y] schools for the boys of the middle class, an[d] the parish schools—now called Board schools—for the children of the lower classes. In th[e] first of these Latin, Greek, and mathematics formed the chief items of the curriculum. I[n] the private schools many subjects were taught but few were learned; and in the paris[h]

:hools the acquisition of the three "r's"—:ading, writing, and arithmetic—were thought mply sufficient in regard to education for ıose who were destined either to work the ›om, to build the house, or to plough the :ld.

But, happily, we have changed all that, and ı our day education is making such rapid :rides that knowledge is within reach of all. ı fact, some enlightened men are asking ıemselves whether or not we are going too ır and too fast. This is a question I do ot propose to discuss; it is not within my rovince. I simply wish to put before you)-day what is being done abroad in regard to ommercial education, so that you may be ble to judge whether or not, in this one espect, England is keeping pace with other ountries.

England was once called a nation of shop-eepers: this was the stigma put upon our ountry by a great military commander; a bit f spleen emanating from the mouth of one 'ho thought that glory to a nation was cquired only in the pursuit of arms. Of one, 'ho knew not that peace hath its victories as 'ell as war; of one who ignored the ladder by 'hich he himself had mounted to fame. It is, nhappily, even to-day the custom among a ertain class to look down upon trade; and his contempt is never more loudly manifested han by those whose immediate ancestors have ıade their fortunes by trading. But, like Napoleon the First, they forget that the pros-erity of a country wholly depends upon its ommerce, and that military glory can only be chieved by those whose one object in fight-ıg is to protect the trading interests of their ountry. We see that Russia is thirsting for ıis military glory to-day: she is ready, and erhaps anxious, to move her battalions across ıe frontier, but she cannot do so, because she s poor; because her commercial and industrial ctivity has not kept pace with the thirst for erritorial aggrandisement, and she is obliged ɔ remain at peace, simply because she is ıcking in the sinews of war.

History shows us that the pursuit of ommerce has even been the mainstay of ations, and, without too much boasting, an nglishman may say that the glorious ıpremacy of Great Britain on land, or on ea, throughout the world, is due to the fact ıat her commercial prosperity has enabled er to retain, by force of arms and length of urse, those vast territories which, in the first ıstance, have been obtained for her by doughty pioneers who have gone forth to trade with the natives of far distant climes. Yes, we are proud of being a nation of shopkeepers, and hitherto we have been able to hold our own against all comers.

But—and there is a but in the case—signs are not wanting that Great Britain is no longer commanding foreign markets as she did only a few years back. Reports have been sent in by our Consuls abroad, showing that orders are now being sent to Germany, to Belgium, and the United States, that were wont to be exclusively forwarded to our great manufacturing centres; and the Board of Trade returns have lately shown that in many cases there has been a considerable falling off in our imports. Mr. Consul-General de Courcy-Perry, from Odessa, was one of the first to give the note of alarm. Mr. James Baker, in his little book, entitled "Our Foreign Competitors," gave point to it by showing that Germany was cutting us out in many of our own fields of industry; and when at length Englishmen opened their eyes to the fact, the question was generally asked, "What must be done to keep the world's trade in English hands?"

Far-seeing men at once realised the truth of what Mr. de Courcy-Perry had proclaimed, viz., that England was not being represented abroad by efficient commercial travellers; by men who could speak the language of the people among whom they travelled, and thus ascertain what was wanted on the market which their employers wished to serve. Other nations were represented by men who had the gift of tongues, and these men booked all the orders. The Englishman worked hard with his interpreter always by his side, but he was never in touch with his customers, and at night his order-book was still empty.

Then came the cry for higher commercial education, and, thanks to such men as Colonel Howard Vincent in the House of Commons, and Sir Albert Rollit at the London Chamber of Commerce, a forward movement was effected; and, as you know, much has already been done to give to lads, destined for a commercial career, an education which will fit them to compete successfully in that great commercial struggle which is now going on in all the markets of the world, and which will be more intense as the new nations further develop their industrial activity. As a proof of this, are we not told that Japan is already bidding for a part of the world's custom. The Japanese have shown themselves apt pupils of their

European teachers in the art of war; they will likewise show themselves apt pupils in the arts of peace.

It has always been said that the counting-house, warehouse, or shop has been the fittest school for the lad destined for trade. This idea, at any rate, has obtained in England, and the boy of fourteen has been taken from his books to be placed in an office where, in copying letters and running errands, he has been supposed to pick up that training which fitted him ultimately to become a merchant or a manufacturer. Formerly, when international communication was very slow, many came out of the ordeal successfully; and it is not an uncommon thing to hear a prosperous business man boast that he had little or no schooling. This was very well in the old days, before the invention of the steam-engine, of the telegraph, and of the telephone. But these inventions gave, with their rapid means of international communication, a fresh impetus to trade. It was found that new men were now required—men quick to discern, quick to decide, their decisions being based upon a thorough knowledge of the state of the world's markets. Such knowledge cannot be gained by those who stay at home, within the narrow limits of an office, and whose mental powers have no other foundation than the limited amount of instruction they received at a proprietary school.

In France, many years ago, this fact was recognised by all thinking men, but it was reserved for Belgium, struggling to find work for her dense population, to be the first to give practical effect to the idea of establishing a special school for the commercial training of her young men. In 1851, our Prince Consort organised the first International Exhibition of All Nations in Hyde-park; his aim was to compare the progress made by the different nations in the industrial arts. The Exhibition was a success, and it showed us—Englishmen—that we held the first place. But other nations profited by the lesson; they began to ask themselves if they, too, could not do something more than they had done in the past to promote their home and foreign trade; and Belgium saw that something could at once be done if she had but competent men to represent her in the foreign markets. Hence, in 1852, some public spirited men, under the leadership of M. Rogier, then Minister of the Interior, approached the Municipality of Antwerp and the Belgian Government, with a view to the establishment of a commercial university. The idea was at once adopted and before the year 1853 closed the "Institut Supérieur de Commerce," or Commercial University, was opened at Antwerp. It succeeded from the very outset, owing to the soundness of the principles on which it was established, and ultimately became the model upon which similar institutions were founded in France, Switzerland, Germany, Italy and even in distant Japan. In giving you this evening a sketch of what is being done in regard to commercial education in Belgium, I shall practically be telling you what is also being done in other countries abroad.

The first difficulty with the promoters of the scheme was the financial one, as in Belgium there were many people who still adhered to the old notion that a small amount of education sufficed for a man destined to be a trader. But the Government at that time was an enlightened one, and with the memory of Hyde-park still fresh in the minds of the Cabinet, it decided to share the expense with the City of Antwerp Corporation. The terms were at once agreed upon, and, as I said before, the class-rooms were opened in 1853, and 51 students were at once enrolled. And from that day to this the Institute has steadily increased its usefulness, in proof of which we find that to-day its courses of lectures are frequented by young men from all parts of the world. It may be useful here to give some statistics on the steady increase in the "population" as the French say.

At the end of the first four years 316 students had been enrolled, of whom 226 were Belgians and 90 foreigners.

During the next four years 348 students, of whom 191 were foreigners.

At the end of 1867 there were 358 students, 194 being foreigners.

At the end of 1872, 571, 229 being foreigners; 1877, 666, 294; 1882, 637, 227; 1887, 683, 281; 1892, 945, 406; and when the next quaternary period shall have reached its term, we shall be able to report a still larger increase in the numbers.

It will doubtless be remarked that it is owing to the presence of foreigners that the numbers have so rapidly increased. This is a fact, but it must not be inferred that the appreciation of the Institute has declined in Belgium. This is easily shown, when the figures are studied, for, in the first quaternary period there were 226 Belgian students, whereas in the last, that ending in 1892, there were 539 students of

Belgian nationality, that is to say, that the numbers had trebled.

And this is not to be wondered at when we consider that, of the old students, there are at this day 249 who occupy the position of chief in the most important mercantile firms of the country; 218 who are bank managers, or commission merchants of high standing; 5 are Belgian consuls-general; 4 are consuls; 5 vice-consuls; 8 others have served the country as acting consuls-general, and one old student is the Home Secretary for the Congo Independent State. In addition to which I may mention that some old students have themselves become professors of commercial sciences in the establishments modelled, in foreign countries, on the same lines as the Antwerp, Institute. This notably is the case at Odessa, Rheims in France, and at Tokio in Japan.

I have introduced these facts in order to show at the outset that the Institute has served the purpose for which it was founded; for it cannot be gainsaid that there are still many business men whose opinions are entitled to respect, who maintain that a school for higher commercial studies has no *raison d'être*. I venture to think that the success in life of the Antwerp students proves the contrary.

For the details of the curriculum I must refer you to the prospectus of the Institute. I will briefly state that the branches of study include all subjects a knowledge of which is indispensable to the merchant, banker, or trader, who wishes to succeed in life.

The students are divided into two classes—the "regular" and the "free." The former attend all the lectures with a view to obtain the diploma or degree at the end of the two years, which period consititutes the prescribed course of study. The "free" student is one who follows only the courses of lectures which he considers of paramount importance to him in his commercial career.

A regular student must pass an entrance examination, in which he must show a competent knowledge of two foreign languages, in book-keeping by single and double entry, in geography, history, natural philosophy, chemistry, geometry, arithmetic and algebra, commercial law, and the elements of political economy. In short, the subjects generally demanded for matriculation at our own universities.

A free student need not present himself for this examination, as he is always free to cease attending the classes when once his particular object shall have been attained.

The course of instruction upon which the student enters, after passing his entrance examination, is practical as well as theoretical. The transactions of a large commercial house are simulated, the operations of a counting-house minutely practised, and all questions relating to the theory of exchanges are accurately described. The correspondence of the "office" must be conducted by the student himself, and that too in French, German, and English, which languages are obligatory. He must also be competent to correspond in one other foreign language, the choice generally being either Spanish, Italian, or Dutch, a professor of each of these languages being on the Institute staff. The principles of political economy, of international commercial law, and customs' legislation, are also inculcated; and special care is taken to make the students acquainted with foreign markets by furnishing them with reports sent in periodically by Belgian residents abroad.

In regard to a knowledge of all kinds of vegetable, mineral, and animal produce, there is a well-furnished museum, with samples and patterns kept up to date, so that the professor is enabled to give to his pupils a practical knowledge of the article in which the latter will one day be called upon to trade. The geographical and economical condition of foreign countries is studied from carefully compiled data, and the relative value of raw material, from different sources of supply, is inquired into and noted.

The student is also encouraged to take a close interest in the political events of the day, so far as these affect commercial interests; and the latest consular reports from all countries are placed at his disposal, so that he himself, later on, may be in a position to make a report upon the commercial prospects of any country in which he may happen to find himself.

In the spring of each year, the principal mines, factories, mills, &c., of Belgium are visited by the students, accompanied by one or more of the professors. In this way, the young fellows acquire an insight into the actual working of those industrial establishments which have done so much to give to Belgium that measure of prosperity which she to-day enjoys.

Another important feature of the Antwerp Institute is the bestowal of travelling scholarships on the most deserving students. These are naturally limited to those of Belgian nation-

ality. A sum of nearly £2,000 per annum is devoted to this object. A student who has passed his final examination with credit is entitled to offer himself as a candidate for one of these scholarships or "bourses" as they are called. If one be granted, he proceeds abroad, with the certainty of enjoying, for three years at least, an annual income of £200. He is thus relieved of the necessity of accepting the first situation that is offered to him; and can devote the whole of his time, if necessary, to the study of the economic condition of the country in which he resides. He must send home periodically a detailed report of the results of his observations; by his previous education he is enabled to do this with a good result, and these reports, after being noted by the Government, are utilised by the students in the prosecution of their studies.

Down to the end of 1892, 62 students had been thus sent abroad; the countries chosen for residence being Algeria, Morocco, the Cape, Japan, China, India, Canada, the United States, the Argentine Republic, Brazil, Colombia, Venezuela, Chili, Mexico, Cuba, Phillipine Islands, Australia, and New Zealand —in fact, those countries in which Belgium is seeking to place her manufactures. Of these 62, 27 have remained in the countries to which, as Bursars, they proceeded, and are now doing exceedingly well as merchants or commercial agents; 16 are established in European countries, also as merchants; and two have entered the service of the Japanese Government as teachers of the commercial sciences.

I have already said that other countries have followed Belgium in the steps she took to improve the higher commercial education of her youth, and at Paris a similar school has been established, which, though still in its infancy, is doing good work. It was not found practicable, however, to introduce into the French establishment such a high curriculum of studies, the result being that students, after studying for a year or so at Paris, come to Antwerp to finish their education. The same remark applies to the different schools in Switzerland, Germany, Italy, and Roumania. Thus, as Antwerp took the initiative in introducing the system, the Institute has been looked upon as the model of such establishments, and its prestige is still undiminished.

To afford another proof that the promoters of the scheme really did supply a long-felt want, I may mention that in 1886, at Bordeaux, an International Congress was opened, under the auspices of the French Government. Th object was to discuss whether or not there di exist any necessity to establish "commerci schools," that is to say, establishments havin a curriculum specially designed for the highe education of youth destined for a busines career. This Congress was attended by man of the leading bankers, merchants, and pro fessors, not only of France, but of othe countries; and, after five days of close an careful deliberation, it was unanimousl decided that to have followed such a curri culum as that pursued at the Institute a Antwerp was calculated most materially to ai a merchant in his career, and the Frencl Government was requested to encourage th establishment of similar schools throughou the country. One leading merchant of a larg French seaport, rose in the Assembly and said that had he enjoyed the privilege o pursuing such a course of studies in hi youth, he would have been saved at least five years of drudgery in the pursuit of that know ledge which has been so essential to his success.

The Institute of Commerce at Antwerp has also been the recipient of honours at the hands of juries at the following exhibitions, viz., Paris (1878), Brussels (1880), Antwerp (1885), Liverpool (1886), Melbourne (1888), Paris (1889), and Antwerp of last year.

It will now probably be asked what is the cost to parents of a higher commercial education, such as that given at the Institut Supérieur de Commerce at Antwerp. It is very small, the expenses of keeping up the establishment being borne by the Belgian Government in part, and the rest by the Antwerp municipality. But each student contributes, that is, pays a fee of about £10 the first year and £12 the second, the amount of which fees are paid to the professors as a supplement to their honoraria, thus following the custom of Ancient Greece. This is called the "Minervale." The Government does its best to procure a really competent teaching staff, and pays so much a year to each "Chair," giving a pension to the professors after a certain number of years' service. There is also a fund to which the professors contribute a small sum yearly, for providing a pension for their widows and for their orphan children until they reach the age of eighteen years. The system works very well: the country has a fair return for its money by the extension given to its trade, and, in allowing the professors to profit by the

er increasing number of the students, you ve him every encouragement to keep him- lf *au courant*, and thus attract students to s chair.

As I have already stated, the study of nguages is a strong feature of the Institute, d at the end of the two years' course there e very few of the young men who quit ntwerp without being thoroughly conversant th the languages most used in the world of de. In fact each student is more or less quainted with three other languages, in dition to his mother tongue. I have known any cases where, say a Roumanian, has been le to write a commercial letter in French, erman, English, and Spanish. His own nguage has also enabled him to understand e same letter, if written in Italian, and his sidence in Antwerp has given him a colloquial owledge of Flemish, which to a very great tent is a provincial form of the Dutch lan- age. In fact, the literary language of anders and Holland is almost identical.

It is this knowledge of foreign languages ich, in itself, gives to the foreign trader a nsiderable advantage over his English mpetitor. It constitutes the most salient int, too, in comparing the attainments of a d educated at home with those of one ucated abroad. I am speaking, of course, ly from a commercial point of view. The erage school-boy in England has a smatter- g of Latin and Greek. He knows how to do the rules of arithmetic, and he does them ll. His geography and history are perhaps ltless. But abroad he finds boys able to lculate, by the metric system, without either n or pencil; and if he attempts to show that knows a little of the classics, nobody under- nds him, for the simple reason that his pro- nciation of the words is a thing to be shud- red at by the ordinary well-educated foreigner. t in England the school-boy, although he y spend four or five years in the study of e French and English grammar, is seldom never taught to express himself correctly in her of these languages, much less in Spanish d in Italian, whereas, as I have already own, a lad, educated in a Continental com- rcial school, generally has four languages his fingers' ends.

Then, again, the student at — say the twerp Institute—is constantly brought into se contact with his fellow students from ssia, Roumania, Brazil, Japan, and China. e forms an acquaintance with these young n, picks up a word or two of their language, and ultimately the friendship of youth develops into the business relations of riper years. Besides, such acquaintances enable him to increase his knowledge of men and manners, of foreign countries, and of customs, and this alone, when he is launched upon the world, enables him also to approach his fellow men with a certain amount of self-confidence; and in his turn to inspire in them the conviction, to use a homely expression, that his head is properly screwed upon his shoulders.

Thus I think I have shown that the aim on the Continent is education rather than mere instruction; and it is this superior education, enjoyed by the foreign commercial traveller, by the foreign merchant, and by the manufacturer, which gives them the pull over their English rivals, and allows them to push their trade in markets, inaccessible to the representatives of English firms.

I hope I have been able also to show that a commercial institute or university does offer tangible advantages to its pupils; and I venture to hope that the day is not far distant when a similar "school of commerce" will be established in London. In the meantime, English parents might avail themselves of the advantages offered by one of the Continental schools. The Institute at Antwerp is open to all, but, of course, a lad must be able to speak and understand French before being able to follow the courses of lectures, all given in French. But in each town there are good preparatory schools, and in the spring of each year special classes are organised at the Institute itself, in order to prepare candidates for the entrance or matriculation examination, which is held in October.

In conclusion, I must state that 17 is the minimum age at which it is considered advisable for a pupil to present himself for admission. The teaching is entirely that of a university, so that it is essential that the young fellow be of sufficiently a serious turn of mind to follow attentively the courses without being subjected to school-boy discipline.

I shall be most happy to give any further information to inquirers, and the fullest information may always be obtained on application to the courteous Director of Studies, Dr. Edm. Graudgainage.

DISCUSSION.

Sir PHILIP MAGNUS said the title of the paper was a little misleading, as it spoke of "Education in Belgium," whereas it dealt almost exclusively with

the education given in one institution in Belgium, namely, the well known School of Commerce at Antwerp. The paper might lead persons to take rather an exaggerated view of the character of that institution, seeing that it was called in the paper a university. The school was housed in a small and rather inadequate building for the number of students educated there, and there was nothing of the university character about the teaching except the fact that pupils entered about the age of 17. The principal feature of the instruction given had been well described in the paper; it consisted in this, the pupils were required to communicate with one another in the school in different languages, and bills of lading and other commercial documents were made out by the pupils and forwarded to one another as if they lived in different countries. This principle had not been followed by any school in Europe so far as he was aware. Another of the best features of the school was the travelling scholarships. There was nothing that could better be commended for the imitation of other countries than that system of awarding scholarships, by means of which the students might take up their residences in some other country. It was quite true as stated that many of the students who had obtained travelling scholarships had been enabled to found houses in different parts of Europe and also in Asia and Africa which had become commercial houses in regular relation with institutions at home. The Belgians had succeeded by means of these travelling scholarships in establishing rather important relations in commercial cities abroad. This was certainly a very important feature of the institution. But after all what it amounted to was this; that the Antwerp institution encouraged students to obtain a thorough knowledge of two or three foreign languages. If in England they could succeed in giving to students a thorough knowledge of two or three languages and travelling scholarships which would enable them to live abroad, a great deal would be done towards promoting commercial education. There were other institutions which were more or less similar to the one in Antwerp. The institution in Paris was on a very much larger scale than that in Antwerp, although it looked up to the Antwerp school as to its father, and had taken what was best in the system of instruction there adopted. A full description of this school and of the other schools of commerce in Europe would be found in a book which he published sometime ago on "Industrial Education." One would like to have heard something with respect to the kind of schools leading up to an institution of this kind, and to know the preparatory education the Belgian students received, but this the reader of the paper had not told them. The fact that students undoubtedly mixed with fellow students belonging to different nationalities helped them very much in their future relations. It was a good thing that a number of young fellows belonging to commercial houses in different parts of Europe should be associated for a year or two together, as they formed friendships which developed afterwards t[o] commercial relations. Without exaggerating [the] benefits of the school, he had endeavoured to t[ell] wherein the advantages of the Antwerp instit[ution] existed. Many foreigners sent their sons ther[e, as] they had an opportunity, of obtaining some k[now]ledge of commerce and business, and at the s[ame] time of mixing with students of different nationa[lities], and of learning various languages, and if succe[ssful] they obtained travelling scholarships. So far a[s his] experience was concerned these were the [chief] advantages which the institution possessed.

Mr. A. PRESTON confessed that he was a [little] disappointed with the paper, as it dealt particu[larly] with one class of society. Commerce depe[nded] upon all classes. He fully agreed with the rem[arks] made in the paper as to the importance of gre[ater] attention to instruction in modern languages, [and] years ago at a meeting of old boys at his sch[ool], when Mr. Justice Charles presided, he pointed [out], having had many years of commercial experie[nce], that the English were under very great disadvant[age] in the forcing of dead languages rather than mo[dern] languages. Attending as he did daily at the R[oyal] Exchange, he was almost ashamed to find the [few] Englishmen who could do what the Germans [did], namely, write freely and speak easily in t[hose] languages. He freely admitted that when he [left] school he understood the elementary work conne[cted] with German and French, but, as to conversing [in] those languages, he was somewhat at fault. [Any] knowledge that he had gained in this respect [had] been through devoting himself to the work, after [he] had left school. There was some advantage in [the] elementary work, but he felt that English boys w[ere] not quite up to the mark in this respect. Co[m]mercial education was not limited to speaking [the] languages or writing them freely. One of the g[reat] failings in regard to England had been that we [had] not devoted ourselves more to technical educat[ion]. Two years ago he had the honour of presiding a[t a] meeting of old boys, and he then stated what [he] would now repeat, that, unless the rising generat[ion] of those entering commercial life understood be[tter] the industries with which they might be concern[ed], they would be beaten by foreigners. A great [deal] had been done during the last few years in [the] matter of technical education in connection with [the] artisan class, and he believed that this was [now] bearing good fruit. If they could inspire the ri[sing] generation not to do shoddy work, much ben[efit] would arise to the whole community. He regret[ted] that there was no reference in the paper to techn[ical] education, as he had attended particularly in [the] hope of hearing something as to how the Belg[ians] had become so expert in wood-carving. The pa[per] only dealt with school education. He did not w[ish] to diminish the value of this in the slightest deg[ree], but, however good theoretical education might [be], he thought unless it was combined with a

›unt of practical education it would not very siderably aid the commerce of the country. It › would have been interesting to learn to what :nt the commerce of Belgium had increased ing the last twenty years. He did not know that ;lish exports had decreased, though they had not eased as they ought to have done, and this was, haps, due to severe competition, and to the fact t goods had not been of the high class usually ibuted to English manufacture. As they had the figures before them on this point, it would difficult to discuss the question.

Ír. P. L. SIMMONDS said he had had some exience in travelling over the Continent and visiting cially different exhibitions and museums, having ped to form the museum of Sydney, New South iles, and Tokio. He was also asked by the late Sir ilip Owen to prepare an exhibition for Japan of silks l cottons as that country was desirous of competing h England, and consequently he took a great l of interest in the subject of the paper, having ›wn Professor Layton ten years ago, when British nmissioner at the Antwerp Exhibition. The techal guilds in London and the Chamber of Commerce re doing a great deal in the matter of commercial ıcation, but enough attention was not paid to foreign guages. Complaint had been made of this matter many British consular reports. Much was being ıe to improve commercial education, and he hoped t still more would be done in this direction. Comrcial museums were being formed in many places road, and he hoped that this would be carried on a larger scale here, as foreign countries re making collections of articles suited to wants of the country to which they were t. The Imperial Institute was also doing nething in the same direction, but to his mind it not make models of the samples suitable for ferent foreign countries.

Ir. G. N. HOOPER thought they were indebted to the der of the paper for drawing attention to higher nmercial education, for although they were making ne progress in this direction, they had lost a great ıl of time, and everything which would promote it s very desirable. Many years ago when wishing send his son to a commercial university he was ommended to go to Rouen, but that establment was by no means so well organised as one at Antwerp, as the foreign students re expected to live in a Café. Establishnts which hoped to attract foreigners would ve to make proper provision for the care of the ıdents in the matter of living. The Antwerp ablishment had a very considerable advantage at its st inception through the influence which M. Rogier s able to exert over the municipal authorities, d he thought if similar help could have been orded to institutions in this country much good ıuld have been done; for instance, the Horticultural College at Swanley, which had been struggling under financial difficulties for years, would have done more good had it received timely assistance. In no country was education self-supporting, but this was a fact which was not recognised in England. They had, in England, a certain number of proprietary schools which had held their own under considerable difficulty, they were, however, exceptions; but education in nearly every country must be supported either by endowment or by rates. At the annual meeting of the Chamber of Commerce held to-day, the education committee proposed a scheme for promoting higher commercial education. Hitherto more had been thought of the workmen than of the employers; though this had not been the case in foreign countries. The London Chamber of Commerce proposed to establish lectures on commercial history, commercial and industrial law, commercial geography, the general principles of currency, foreign tariffs, the laws in relation to arbitration and conciliation, prices, principles of banking, &c. It was very desirable that young men should realise that although British commerce at present was flourishing, some great convulsion might take place by which it would be placed in danger, if not extinguished, as had happened to other nations.

The CHAIRMAN, in proposing a vote of thanks to Professor Layton, said, of course technical, as distinguished from commercial education, held the first place in our thoughts, as England was a manufacturing country. As England produced so much, she must learn to distribute, and to find new markets. The old commercial traveller would have to give way to a higher and better type of man. The question of modern languages was undoubtedly the crux of the whole matter. Unfortunately England was not a place in which to learn foreign languages; on the Continent one could hardly help learning different languages, as would be seen in the case of Poles and the Swiss. The question of foreign languages was a very difficult one, and he thought if anyone would show them how to teach foreign languages in public schools he would be a great benefactor. At the Catford College French and German were taught in a conversational way, which he considered an excellent method. But the difficulty was this, that boys would not talk French or German during playtime. The conditions of life in a foreign town were in themselves a means of education to English lads. Still, this ought not to discourage England from doing its duty of providing proper commercial schools. The Central Foundation School, with which he was connected, proposed shortly to establish a department for higher commercial education. Many prophesied that it would be a failure. One good thing with regard to the future of commercial education in London was the fact that the Chambers of Commerce had taken up the matter. The London County Council also proposed to establish a school of economics

at which Professor Hewins would deliver a course of lectures upon the scientific side of industry, and other gentlemen of well-known ability would explain difficult and complex problems. As to trade museums, which no doubt ought to be annexes of all commercial schools, there was a difficulty of establishing them in London, as it represented so many industries. In Bradford, for example, it would be easy to establish a trade museum, as they had a staple industry, but in London the museum for the Mincing-lane market, for example, would have to be very different from that of Mark-lane, and so on. The evening instruction given at the Polytechnics would do a great deal to supply the void to which their attention had been drawn that evening by the reader of the paper. Although Prof. Layton had hardly dealt with the whole subject of commercial education in Belgium, still he had drawn their attention to what a higher commercial school might be, and, having that ideal in their minds, they would be able to apply the lesson, and he hoped that everyone in their various capacities would not fail to try and solve the problem of commercial education adapted to the condition and requirements of England.

The vote of thanks was then put and carried.

Prof. LAYTON writes in reply:—I very much regret to find, from the remarks made by Sir Philip Magnus, that he considers the title of my paper misleading. It is true that I dealt exclusively with the Antwerp Institute, but I considered myself entitled to do so on the principle of *ex uno disce omnes*, all similar institutions on the continent being founded almost identically on the same lines as the establishment I described. Sir Philip says that the school is housed in a small and rather inadequate building. This is only too true; but I venture to think that one does not refuse to doubt the authenticity of a picture by Rubens merely because it has a very bad, worn-out frame. But this defect—a serious one, I admit—is about to be remedied, and the Municipality of Antwerp has granted a sum of half a million francs for new buildings. These have already been commenced, in the southern part of the town, on a site adjacent to that occupied by the city's world-renowned "Musée" or Picture Gallery. Sir Philip also says that the institution in Paris is on a much larger scale than that at Antwerp. This also is true, so far as the number of students in attendance is concerned. But one must not lose sight of the relative population of the two countries; so that what is large for Belgium is small for France. One must only judge the two institutions by their respective merits; and it is a significant fact, as I have already stated, that students come to Antwerp to finish what they have only begun in Paris, even after going through the whole course of lectures there. Sir Philip has ably summed up the advantages claimed for the Antwerp Institute; I myself have claimed no more. Mr. A. Preston regrets that I have only dealt with class of society, but I would respectfully remind that, owing to the very small cost of attendanc the Institute, the classes at the Institute are practi open to the poorest of those who are likely to up commerce as a means of gaining a livelihood will go further, and state that any boy in Belgi who is able to show that he can follow with ad tage the course of lectures given at the Institute, petition the authorities; and, if he be deservin such assistance, he is allowed to attend the Insti gratuitously—and no publicity whatever is give the fact. Mr. Preston also regrets that there is reference to technical education, and espec mentions wood-carving. I should have been ha to have introduced the subject. I have care studied it; but I understood that I was invite deal exclusively with instruction, as applied to higher commercial education of youth. In regar the increase of Belgian commerce, I could easily h incorporated some statistics in my paper, but I fe to trespass too much on the time and patience of audience. Mr. P. L. Simmonds has spoken of value of commercial museums: that of the Instit is admirably well furnished (he himself, I believe 1885 largely contributed to it), and when the buildings shall have been completed, the museum the Institute will be second to none in the wo Mr. Hooper has dealt with a very serious defect regard to the organisation of the Antwerp Institu I allude to the lodging of the students. The syst abroad is radically different from that obtaining England; at Edinburgh, however, the stude are all non-resident. It must not be forgott that only by allowing young men to regulate th own expenses for living, can you tempt them, af leaving school, to devote two or three years more their life to further study. Many would go to Oxf and Cambridge were it not for the expense; a certainly Edinburgh has been the *alma ma* of many men most distinguished in every w of life. But even this subject has recei the attention of the authorities; and foreign stude can find board at the "Athenée Royal" or Hi School on very moderate terms. Some of the pr fessors also receive into their homes private pupi but, of course, in this case the terms are comme surate with the advantages enjoyed. The Chairm (Sir Owen Roberts) has said that he has be advised that any attempt to establish a higher co mercial school in England would be a failure. must respectfully beg to differ from him: but eve thing would depend upon the organisation of such scheme. There is one thing certain: education England is not self-supporting. The reason why not far to seek. But there it is, and I believe that an establishment, similar to the Institut Supérieur Commerce of Antwerp, were founded in Londo and properly endowed, it would attract to its class students from all parts of the world. I cannot clo these remarks without expressing the regret I feel

ing that my paper may be considered as having en incomplete. I can only hope that I shall have honour, at no distant date, of being invited to e you information supplementary to that therein orded.

Miscellaneous.

HE USE OF QUEBRACHO IN TANNING.

According to a recent German trade report, the rman tanners are now adopting the use of ebracho and other tanning materials such as i divi, myrobalanus, japonica, mimosa, valonia, gobilla, &c., in place of oak bark. The leather lustry in Germany has shown great progress in ent years, and the new tanning material of ebracho has produced a revolution in tanning per and sole leather. Quebracho is now used over Germany and in other countries on the ntinent. Quebracho wood is imported principally logs and on sailing vessels. It came originally from province of Santiago, in Chili, but this source of oply is gradually becoming exhausted. In recent ars, in the Argentine Republic, extensive forests of ebracho have been opened up. Of quebracho, two ieties are known, the red and the white. Red ebracho is richer in tannin than the white, the erage contents being from 18 to 20 per cent. nsidering the intrinsic value of this tanning mate-l, it is cheaper than oak bark, and nearly as cheap hemlock. Owing to its very high per-centage of nning qualities, quebracho contains relatively a all proportion of so-called non-tanning substances, d in this respect it has much resemblance to mbier. These non-tanning substances are an portant factor in the manufacture of leather, as ey fill and nourish the leather, and also impart the cessary acidity to liquors, although not assimilating a direct manner with the fibre of the hide. uebracho, it is stated, does not possess a sufficiency these non-tanning properties to yield well-nourished thers, and its use, therefore, is only to be recom-nded in combination with other agents stronger non-tanning substances. The supply of que-acho may be considered inexhaustible. Nearing thirty-first degree of longitude in the Argentine epublic, the Pampas, the largest grazing lands own to the world, gradually develop into immense ests known as chaco. The chaco is wonderful for luxuriant and varied vegetation; within its limits found all kinds of tropical trees—among these abundance the red and white quebracho. The l quebraco, like all other trees found in these gions, with the exception of the palm, does not ain a great height, although the trunk is well veloped. Of a reddish brown this wood is heavy d hard, and has tanning qualities which of late ars have become highly appreciated in Europe. Formerly quebracho wood was obtained only from the forests bordering on the Parana River, but now transportation by rail is possible, and gigantic saw milling enterprises have been started which develop the untold wealth of the chaco and send their products to market. It is stated that the tract of country can furnish a fabulous amount of quebracho wood, practically an inexhaustible amount, while the present yearly consumption is but one million tons. Ten years ago the exports of wood from the Argentine Republic aggregated in value £15,000; during 1892 this value had increased to £300,000. Very recently a saw mill has been erected at each of the ten railway stations between Rosario and Beurequiste. The Government allows the privilege of cutting timber within its boundaries, but makes no grants for more than 13 leagues. One league of forest in the vicinity of the railway is considered from £1,500 to about £2,000. On the value of the woods arriving at the sea a tax of 3 to 7 per cent. is levied. The unlimited supply and low cost of production make quebracho wood one of the cheapest vegetable tanning materials known. About one hundred blows with an axe and a few hours' labour spent in peeling the bark and sawing the logs, suffice to secure a ton of wood, whereas it is estimated that about 150 working hours are required to supply a ton of oak bark. The grinding and cutting of quebracho wood is naturally a more difficult operation than getting out hemlock or oak bark, but considering the original cost this is relatively an unimportant item. Transportation from the Argentine Republic to Europe can be effected so cheaply that many firms ship their rough lumber to Europe to be worked into extract there. The red quebracho contains in considerable quantity a red colouring matter, which is hardly soluble in cold water, but will dissolve readily in warm water. For this reason quebracho extracts, if not properly treated, will impart a reddish tint to leather. Used alone quebracho extract will only yield a leather of poor colour, but when combined with alum and salt it yields finer results even than gambier. Leather tanned with quebracho, alum, and salt has a pale straw-yellow appearance, the flesh side being almost white. In first using quebracho extract it is important to use much weaker liquors than those needed with other tanning agents. There are large extract works in Reuners and Benrath, near Hamburg; also in Oberlahnstein on the Rhine, and Frankfort-on-Main. In these factories the wood is cut by machines specially built for that purpose. It is cut from the log in two different ways —side and head cut. The side cut is of fine, thin, small chips, up to about one inch long, and the head cut consists of smaller and coarser pieces. Quebracho extract is manufactured in crystal and soft paste. The crystal is put up in cases of 150 kilogrammes (330 pounds avoirdupois) and costs about £2 15s. It contains about 65 to 70 per cent. of tannin. The paste is put up in barrels of from 230 to 250 kilogrammes (506 to 550 pounds avoirdupois), and contains about 45 per cent. of tannin.

Notes on Books.

Organic Chemistry.—The Fatty Compounds. By R. Lloyd Whitely, F.I.C., F.C.S. London: Longmans, Green, and Co. 1895.

This is a short work of about 200 pages, which deals, as the title indicates, only with a part of organic chemistry—the hydrocarbons, and their derivatives of the fatty series as distinguished from the aromatic series of benzene and allied compounds. The arrangement of the book so far as theory is concerned, calls for no special notice; it resembles that adopted in most similar works. The special feature is the practical part introduced in the text. After the description and relationship of the principal derivatives the processes of preparation are given with practical details for manufacture on the small scale. A useful plan is adopted of specially indicating by a mark those preparations which can be fairly easily carried out. The directions given are short but clear and sufficient, and in each case the characteristic tests follow the methods of preparation and purification. The author is evidently fully alive to the advantage which a student gains in studying organic chemistry if he supplements his reading by making in the laboratory typical examples of the chief groups of compounds. There are several useful illustrations of necessary apparatus given with the preparations.

A Text-book of Inorganic Chemistry. By G. S. Newth, F.I.C., F.C.S. London: Longmans, Green, and Co. 1894.

This work is divided into three parts. The first twenty-three pages of Part I. contain elementary considerations of the broad distinctions between chemical and physical changes and between elements, compounds, and mixtures. The expressions, chemical affinity and chemical action, are explained, and two short chapters are devoted to chemical nomenclature and the applications of chemical symbols. The remainder of this part, 127 pages, consists practically of physical chemistry, or rather forms a good introduction to this branch of science. The generalisations upon which the atomic theory is based are given clearly, and are appropriately followed by a chapter illustrating the meaning of atomicity or valency. This portion of the book continues with an outline of the general properties of gaseous, liquid, and solid matter, and concludes with a short introduction to thermo-chemistry. Part II. deals with the chemistry of the four typical elements, hydrogen, oxygen, nitrogen, and carbon. In Part III. the rest of the more important elements are arranged systematically according to the periodic classification. It has always been a difficulty to decide how to classify the elements in dealing with beginners in the subject. Some general acquaintance with the facts and principles of chemistry seems to be required before the arrangement based upon the natural system of Mendelejeff can be properly appreciated. By separating the four typical elements and their chief [com]pounds in Part II. the author considers that he [over]comes this difficulty to a great extent. In "hi[nts to] students" a good suggestion is made that begi[nners] should master this part, and the first twenty[-three] pages of the book, before attempting that port[ion of] Part I., in which the physical principles are [more] fully elaborated. To many, especially to [those] whose training in physics has been but slight, [a] familiarity with the facts based upon experim[ent is] necessary before the general principles can be gr[asped] at all. Such students would do well to follo[w the] author's advice. The matter in this book is [very] well illustrated with experiments. The rea[der is] frequently referred for further extension in this [direc]tion to the author's "Chemical Lecture Ex[peri]ments." Additional interest is given to the [more] purely chemical chapters by the appropriate i[ntro]duction in small print of some of the recent au[then]ticated discoveries. Throughout the book the [facts] and theories are put before the reader in an inte[rest]ing and readable manner.

MEETINGS FOR THE ENSUING WE[EK].

Monday, June 10...Engineers, Royal United Service [Insti]tution, Whitehall, S.W., 7½ p.m. Mr. H[enry] W. Umney, "Safety Appliances for Elevato[rs."]
British Architects, 9, Conduit-street, W., 8 p.m.

Tuesday, June 11...Medical and Chirurgical, 20, Han[over-]square, W., 8½ p.m.
Photographic, 12, Hanover-square, W., 8 p.m. Prof. W. C. Roberts-Austen, "The Recordi[ng of] High Temperatures by Photographic Means[."] Capt. Abney, "Orthochromatics."
Anthropological, 3, Hanover-square, W., 8½ [p.m.] Prof. A. C. Haddon, "The Ethnography of B[ritish] New Guinea."
Colonial Institute, Whitehall-rooms, Whit[ehall-]place, S.W., 8 p.m. Sir William Robi[nson,] "Western Australia."

Wednesday, June 12...Botanic Gardens, Regent's-[park,] N.W., 2 p.m. Special Floral *Fête*.
Japan Society, 20, Hanover-square, W., 8½ [p.m.] Mr. Arthur Diósy, "Some Difficulties encoun[tered] by Beginners in the Study of the Japanese-sp[oken] Language."
United Service Institution, Whitehall, S.W., 3 [p.m.] Captain W. H. James, "The Insufficiency o[f a] Navy without a proper Army for the Mainte[nance] of the British Empire."

Thursday, June 13...Royal, Burlington-house, W., 4½ p[.m.]
Antiquaries, Burlington-house, W., 8½ p.m.
Society for the Encouragement of Fine Arts, 9, [Con]duit-street, W., 8 p.m. Mr. J. W. Tonks, "Ma[yoral] Chains and Civic Insignia."
Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, June 14...United Service Institution, White[hall,] S.W., 3 p.m. Commander W. C. Crutchley[, ...] Mr. H. Lawrence Swinburne, "Suggested [...] of Convoy in War Time."
Physical, Science Schools, South Kensington, S[.W.,] 5 p.m. 1. Mr. H. F. Barstall, "The Measure[ment] of Cyclically Varying Temperature." 2. [...] N. F. Deer, "The Thermal Constants of the [Ele]ments." 3. Mr. F. W. Bowden, "An Ele[ctro-]magnetic Effect."

Saturday, June 15...Botanic, Inner Circle, Regent's-[park,] N.W., 3¾ p.m.

Journal of the Society of Arts.

No. 2,221. Vol. XLIII.

FRIDAY, JUNE 14, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One lundred and Forty-first Annual General Meetng for the purpose of receiving the Council's ?eport and the Treasurers' Statement of eceipts, payments, and expenditure during he past year, and also for the election of fficers and new members, will be held in ccordance with the Bye-laws, on Wednesday, 6th June, at 4 p.m.

(By order of the Council)
HENRY TRUEMAN WOOD,
Secretary.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take lace at the South Kensington Museum (by ermission of the Lords of the Committee of Council on Education), on Wednesday, June 9th.

The reception will be held by Major-General ir John Donnelly, K.C.B., Chairman, and he Members of the Council of the Society, rom 9 to 10 p.m.

Each member is entitled to a card for himelf, which will not be transferable, and a ard for a lady. In addition each member vill be able to purchase two transferable ickets, the price of which will be 5s. ach up to the day of the *conversazione*; n that day the price will be raised to s. 6d. It is requested that members requiring hese additional tickets will make early appliation for them. Every application must be ccompanied by a remittance.

Promenade Concerts will be given in the North Court and in the Textiles Court of the Iuseum, commencing at 9.15 p.m.

A Glee and Madrigal Concert will be given at intervals in the Lecture Theatre, commencing at 9.30 p.m.

A Vocal and Instrumental Concert will be given in one of the galleries of the Museum, commencing at 9.30 p.m.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied at the usual Refreshment Buffets in the Central Corridor of the Museum.

As the old Museum quadrangle is now covered in, none of the entertainment will be in the open air.

Further particulars as to the musical and other arrangements will be given in the programme, which will be distributed on the evening.

The cards of invitation have been issued to members.

TECHNICAL EDUCATION CONFERENCE.

It has been suggested to the Council of this Society that a useful purpose would be served if the Society were to afford to those who are interested in Technical Education in different parts of the country an opportunity of meeting together and discussing the measures which the Society might take, with a view to enlarge the scope of its present action in this matter, and thus aid local authorities in giving effect to recent legislation on the subject.

The Council have, therefore, determined to hold a Conference of representatives of the Technical Instruction Committees of the various County Councils, and others interested in the subject, on Thursday, the 20th of June next, at the House of the Society of Arts, John-street, Adelphi, London, W.C. The chair will be taken at 3 p.m. by Major-General Sir John Donnelly, K.C.B., Chairman of the Council of the Society of Arts.

With the view of eliciting the views of those attending the Conference, the following Resolutions will be suggested for consideration:—

1. That it is desirable that the Society of Arts should extend its system of Examinations, and provide for examination and inspection in those subjects which are not taken up by other bodies.
2. Further, that it is desirable that the Society of Arts should arrange for an office and central organisation, from which information, advice, or assistance might be obtained, and through which arrangements might be made for inspection and examination.

Tickets of admission to the Conference can be obtained on application to the Secretary of the Society.

Proceedings of the Society.

INDIAN SECTION.

Thursday, May 23; SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., Vice-President of the Society, in the chair.

The CHAIRMAN, in introducing Mr. Yates to the meeting, said that, after a brilliant career at Cooper's-hill College, he had gone out in the Public Works Department to India, where, in the course of his service, he had been employed for 17 years on the irrigation works of the Punjab. But he had engaged himself in other than his professional pursuits, and was one of the few Europeans who had acquired, not only a practical, but a scholarly knowledge of the language of the Baluchis. He was also one of the translators of the New Testament into Baluchi. He had an unrivalled knowledge of the subject of his paper. In conclusion, the Chairman read a letter from General Sir Frederic John Goldsmid, K.C.S.I., C.B., expressing his deep regret at not being able to attend the reading of Mr. Yates's paper. Sir Frederic continued:—"Will you kindly express to your Society my most grateful acknowledgments of their courteous consideration and kindness in sending me invitations to the meeting on the 23rd inst. and previous meetings? They are almost the only recognition which I receive in my older years of my having been in my younger years employed in important positions under the Government of India." Sir Frederic Goldsmid had also served the Imperial Government in Turkey and Egypt, and always, everywhere, with the highest acceptability and distinction; and his letter was a scathing reflection on the proverbial ingratitude of the State towards men with whom the first principle of public duty was self-effacement. Modesty was a pre-eminently Christian virtue, but its reward was not in this world, not even in officially Christian countries.

The paper read was—

THE NORTHERN BALOCHIS, THEIR CUSTOMS AND FOLK-LORE.

BY OSWALD V. YATES.

In the year 1884 the study of the Northern Balochi dialect was in its infancy, there being only four officials in the Indian service who could speak the same, one of them being myself. Messrs. Gladstone and Bruce attempted a grammar, but the best paper on the subje was that written by Mr. Longworth Dames f the Asiatic Society of Bengal, in the ye 1880. This was the only attempt made render the subject interesting, by a collecti of riddles and folk-lore, and the object of th paper is to make it, if possible, more so, l adding a little to that already told.

For a period of two years, I was resident the district of Dera Ghazi Khan, the home the Northern Baloch, and had attached to n staff a Baloch who was illiterate. From hi and his fellow-tribesmen much of the i formation in this paper was collected, all t folk-lore being taken down exactly as dictate to me, and afterwards corrected where it wa required. A method of spelling was laid dow by my predecessors following closely that the Persian language, from which that of th Baloch is undoubtedly derived, and this spel ing I have adopted all through this paper.

The north-west frontier of India is practicall a continuous range of mountains from the Kara kuram to the Indian Ocean, and, at the sam time it is the only side from which India eve has been, or ever can be, invaded. It is we known now that in this range there are abou 300 passes, what wonder then that the restles tribes beyond, should have made use of thi great highway? Commencing from the Indus we have a broad plain about forty miles wid inhabited by the Jhuts and miscellaneou Balochis, then we come to the hills about 10 miles wide peopled with the Balochis an Pathans, then Afghanistan, then in the fa distance, gradually lessening, Russia. Fron Peshawur to a point about midway betwee Dera Ismail Khan and Dera Ghazi Khan, distance of some 300 miles, these mountain are inhabited by Pathans, and in this sectio are the main routes to Kabul and Ghazni from this point the Northern Baloch countr begins and extends all through the district o Dera Ghazi Khan, with which this pape deals. Between the Baloch country an Afghanistan lie the Pathans, the hereditar enemies of the Balochis, and with whom the are incessantly at daggers drawn.

Opposite Dera Ghazi Khan and about four teen miles distant is the Vidor Pass, occupie by Balochis, and through which it is sai that Nadir Shah, the Persian, invaded Indi during the last century. It will be remembere that six such invasions took place in abou twenty-three years, the first being a Persia invasion, the others Afghan; Nadir Sha retired from India after sacking the city o

Delhi and taking away about £9,000,000 sterling. This is of course a matter of history which everybody knows, or, perhaps, should know.

Balochistan, as a whole, extends along the coast of the Indian Ocean, from the River Indus to the straits of Ormuz, beginning on the east with Cape Monze, or Ras Muaree, and terminating with Cape Jask on the west. Its area is put down in the "Indian Gazetteer" as 106,500 square miles, or about the surface of the British Isles, and one quarter more. Formerly considered as belonging to Persia, and afterwards dependent on Cabul, it is now entirely under the control of the Indian Government. The Suleiman Mountains, the home of the Northern Baloch, are thrown off from a range commencing at the Allah Koh ridge, between Cabul and Ghazni, and then continuing south, proceed in an almost unbroken line to the Arabian Sea, near Karachi.

This range is of small elevation, excepting the two peaks of the Takht-i-Suleiman, 11,295 feet and 11,070 feet respectively; the surface is so bare of vegetation, and sandy and stony, that the heavy rainfall is absorbed, and no permanent streams are formed. During the rains the watercourses become torrents, about a mile or more wide, and in a few days almost disappear, becoming perfectly dry in the hot season. Their beds, when dry, are overgrown with jungle and mountain grasses, which afford excellent grazing for their favourite animal, the horse, and also for cattle. In the hills there is more pasture than cultivation, but in the plains below, termed the Pachâd, the reverse is the case. A description of their methods of cultivation will be given further on.

All kinds of grain grown in India are cultivated, rice, wheat, barley, bajra, moong, Indian corn, dal (vetch), mattar (peas), til (sesamum), and gram (*Cicer arietinum*). I have heard it said, and with a good deal of truth, that in a good season of rainfall the crops grown are sufficient to keep the people for a period of three years, and this is especially the case at Dajjal, in the Dera Ghazi Khan District. From this latter place the people often go ten miles for water in the hot season. The principal timber trees are *Zisyphus Jujuba*, a very hard wood, and the tamarisk; no trees as known in England are grown.

Originally the Balochis were divided into three tribes, the Nharois, the Rhinds, and the Maghasis; the first of the three dwelling in the south, and the other two in the north. On this point there is much difference of opinion, and Mr. Dames says the number was five, and that the Dodais were not Balochis, as usually stated. I give here his note from *Panjab Notes and Queries*, to which I was once a contributor:—

"It is usually stated ("Ibbetson Outlines of Panjab Ethnography") that Dera Ismail Khan, Dera Fatch Khan, Dera Ghazi Khan, were all founded by the Dodai tribe of Balochis. This was no doubt true of Dera Ghazi Khan. The Mirranis, who ruled there so long, were certainly a branch of the Dodais. But Dera Ismail Khan was founded and held, according to all accounts, by the Hots, who are one of the five original divisions of the Balochis; Rind, Lashari, Hot, Korai, Jatoi. They could not be, therefore, a branch of the Dodais, who are not pure Balochis at all, but an affiliated tribe of Jat origin. They belong to the Satha Somra, a collection of Jat or Rajput tribes, which held the country before the Baloch irruption. They held Dera Ghazi Khan, or whatever its name was before the conquest, and continued to hold it afterwards, being too strong to be expelled. The legend says that Salhe Rind gave his daughter in marriage to Doda, and from this union sprung the Dodai tribe, who were held to be Balochis. An old ballad says—

"Pha jan sângâ, mar Baloch bîthâ,"

On the woman's account, the man became Baloch. The legend of Mir Chakur, the great Baloch leader, states that in his march to India they reached Tulumba, where a split took place among the Rinds, many of whom refused to go further, preferring to stick to the lands they had already acquired Trans-Indus. Among these were the Mazaris, who retired into the mountains now occupied by the Bugtis. Another section of Rhinds broke off, headed by Bijara, cousin of Mir Chakur.

"The latter thereupon entered into a treaty with Sohrab Khan Doda, who returned to Dera Ghazi Khan to attack Bijar and the Rhinds, which he did apparently with success. Ismail Khan, the founder of Dera Ismail Khan, is called the son of Sohrab Khan Dodai. As however all his descendants were Hots and not Dodais, this is probably a mistake. The Hots were associated in the occupation of the Dera Ismail Khan and Laiah territory with the Jistkanis, also a pure Baloch tribe. Altogether it seems probable, that the Dodais were a tribe localised in the lower Derajat, and that although admitted to the Baloch fraternity, they did not accompany the invaders on their further wanderings. Like the Dodais, the Gorchanis, as regards some of their sections, are said to belong to Satha-Somra, and the story of their founder Gorish is similar to that of Doda. A Jat tribe, named Sumra, still holds a leading position among the landowning tribes in Laiah and may perhaps be connected in origin with the Dodais and Gorchanis."

But whether there were three, or five, or six tribes (including the Dodais), originally, there

are now some seventeen sections, or as they call themselves tribes, who speak the Northern Balochi dialect. They are Rinds, Dhombkis, Maghasis, Jakranis, Marris, Bugtis, Mazaris, Drishaks, Gorchanis, Lasharis, Durkanis, Legharis, Hadyanis, Lunds, Khosas, Bozdars, Kaisaranis, all of whom come in contact with people speaking Brahui, Sindi, Pashto, and Panjabi.

The Dombkis and Bugtis speak the best, and the Bozdars the worst Balochi. The Brahuis speak the language, when conversing with Baloch tribes. Sindi and Panjabi have affected the language much, and it is extremely difficult at times to discern whether words are genuine Balochi or borrowed; the northern and southern dialects are so different that the tribes of the north and the south do not understand each other.

No book has yet been published to satisfy all the wants of Balochi scholars; what is most urgently needed to make the study of the language interesting, is a collection of folklore and legends, and from this a vocabulary should be compiled. Major Mockler has written on the southern dialect, and Mr. Dames on the northern, but more is wanted.

The Balochis say they came from Aleppo which they left about 1200 years ago, and after wandering in Persia, settled on our north-west frontier, 300 years back. The admixture of Persian words in their language proves that they must have lived amongst people speaking that tongue, and Pottinger who travelled in Balochistan about the year 1830, says that he could, after a few weeks residence, understand most of what was said to him, he being a good Persian scholar.

A difficult question now to decide is, Who are the Balochis, and from what race are they sprung? This is a point on which I seek information. Many will tell you that they are Tartars, but this means little. In the Mongul language the word "Tartar" means a tributary people, and by this name all tribes were designated by the Mongols when they had conquered them. It has thus become a collective name. The Balochis have a great look of the Mongol, they are Sunni Mahomedans, and, so far, none have been converted to Christianity. The Pashalik of Aleppo was inhabited, at least, as far as the south is concerned, by Kurds and Arabs, so I suppose that the Balochis must be reckoned as a mixture of the two.

A Balochi, on meeting another, does not say "Salaam," as other Mussulmans do, but says "Byâthi durr shâkhte," meaning "welcome," to which the other replies "mahaira," meaning "it is well." Conversation then commences, each addressing the other as *thi* or Thou, only occasionally do they use *shwâ* or you. In this respect their language is very like Punjabi. A woman addresses a man as "Byathi adda," and he replies "hair bâs manî."

This form of address being so totally different from that of all the eastern races with whom I have come in contact, places me in rather a greater difficulty as regards their origin than before; hence I am unable to give any further information than is given above.

During the last twenty years, much has been learnt of this interesting race, of which previously little was known. In 1800 there were many travellers in their country, but it was not the Balochistan of to-day, nor were the Balochis the amenable race they are at the present time. British influence was then of the smallest and they were a people dwelling in tents, a number of wandering tribes, preyed upon by others, and in turn preying upon them. About one hundredth part of their territory only was cultivated, not because it would produce nothing, but because of the lawlessness that prevailed.

The men used to tend the flocks and till the ground; the women were employed in milking, butter-making, cheese-making, preparing *ghee*, or clarified butter, working carpets, felt and coarse white cloth.

The Institutes of Manu, written some 2,000 years ago, prescribed a desert 20 miles wide along the frontier of a royal kingdom or city so that no army could invade it, owing to the want of food and water in this wilderness; this was the state of affairs when the British entered upon the scene, a truly non-scientific frontier.

On the subject of the north-east frontier Sir William Hunter remarks, "the unscientific frontier of the last century signified that 60,000 square miles of country were abandoned to jungle and wild beasts, not because there were no people to cultivate the soil, but because they did not care to do so." Now what does this mean? It means that a district which could yield some £30,000 of revenue lay untilled through terror of the turbulent hill tribes.

One century of British rule has brought under cultivation some 13,000 square miles of country, yielding a revenue of £16,000,000 annually, or about the cost of the Indian army

nd the defence of the empire. This policy as applied to the north-west frontier, with the ame results, and now the Balochis are well isposed to the British, besides being pleasant to deal with; very different from their neighbours, the Pathans.

Mountain frontiers have one great disadvantage, which is, that unless the Border tribes are ell under the control of the ruling power, they imply retire to their hill fastnesses, whenever n attempt is made to suppress them for any awless acts committed beyond their border. Pursuit under those circumstances is useless, nd thus the friendly relations with the Balochis, ave been and will prove a very great help to he Indian Government.

One thing they were never tired of telling ne, and that was, when they first came under ur influence, a promise was made to them, with what truth I cannot say, that if they nlisted in our army, regiments would be ormed exclusively of Balochis. This promise, hey say, was kept until the stirring times of he Mutiny of 1857, when class regiments were formed; this so disgusted them, that hey made a vow never to wear our uniform gain, though they would always help us, as evies, or in any form they could. Many of he tribes have kept this vow, many have not. Numerous concessions have been made to hem, and one which they greatly appreciate, iz., that when in gaol their hair shall never e cut like that of other prisoners, owing to he disgrace it brings upon them, when they eturn to their tribe, has done much to enlist hem on our side.

A Baloch, to be respected, must have long, lack, curly hair hanging over his shoulders. This is washed frequently, but as it is immediately anointed with *ghi*, or clarified butter, he washing is not of much use. The longer he hair, the more the Baloch is respected; the leaner his clothes, and the more stuff there s in the legs of his shalwars or pyjamas, the icher he is supposed to be.

A Baloch has one form of insulting a man; t is called, in Balochi "Bujha Deagh," or to nuff out, and consists in spreading out the eft hand, and turning it palm forward, in front f the face of the person to be insulted, saying t the same time, "Ma thara bujha dean," I will snuff you out. I only saw it once done by a non-Baloch to a Baloch whom the former had bested in a law court; a Baloch will never do it even in jest, to a friend or enemy, unless horoughly roused, which is very seldom.

The Balochis have the utmost contempt for any Oriental race which does not live in the hills, for anyone who does not speak their language, and for anyone who cannot ride a horse properly or use a sword. They maintain that their race never practised deceit until they came into contact with the pleaders in the British Law Courts. Before they came under British influence, all their disputes were settled by meetings of the tribes, and their awards were rough and ready. Their hospitality is unbounded, their favourite sport is racing. Housebreaking has no charm for them, private theft is considered dishonourable, but marauding expeditions have a great charm for them, and are considered to be a legitimate form of sport. In the case of adultery, they are unappeasable. If the fault is that of the woman, she is hanged, and then the man is sought out for the same purpose; if the man is the aggressor, then he is hanged, and the woman searched for. Blood for blood is a matter of honour, and in this respect we have been unable to change their ideas. With the Pathans, of all classes, they are incessantly at war, in some form or other, and never are they so happy as when a marauding expedition into their country has returned successful.

Black beards are a distinguishing feature of their race, rather more elongated than that of the Indian Moslems; but a story is told of a Baloch at Rajanpur, whose beard turned white when his wife was *enceinte* at a time not expected. They treat their women with respect, and during their wanderings the latter never wore the veil; it is only since they came in contact with the Indian Moslems that they have taken to wearing it whenever they go out. In form, it is like the Egyptian or Turkish yashmak, and not like the Indian chaddar or the Pârsi "sari." The men are allowed to carry a sword, which is slung through an ornamented shoulder strap, another privilege of which the Panjabi is very jealous. For the Jhut of the Derajat plains, they have the greatest contempt, principally because the Jhut imitates the Baloch in his dress, and cannot speak his language. Even their own tribesmen, who from long residence amongst the Jhuts have forgotten their own language, are frequently looked down upon.

All non-Baloch Mahometans in the Dera Ghazi Khan district, are called Jhuts by the Hindus, but the Mahometans apply the name commonly to villagers and cultivators, and only as a term of reproach in towns, if they are particularly stupid. The real Jats call themselves Jat and their language Jataki.

"Jaghdal" and "Jaghdali" are Baloch terms.

Agriculture in the Pachâd is reduced to a science, at least as far as the irrigation of the land is concerned. Before the commencement of the rains the fields are enclosed by lofty embankments, varying in height from three feet to ten feet, and inside these banks (called "Latbandi") the water from the hill torrents is admitted; when one is full the next is filled. Quarrels over this distribution are frequent, and occasion bloodshed. The banks are made by bullocks. A board about 18 inches long and 12 inches broad is attached to a pair of bullocks, who drag it along almost vertically until a heap of earth is raised in front of it; this board is then thrown flat by means of a cord, and dragged on to the bank with the earth on top of it, and there its load is deposited; by this method, when some 300 pairs of bullocks are employed, they soon raise a bank, and one so solid with the constant trampling of the animals concerned, that a leak is almost impossible. If a breach does occur the country is flooded for about twenty miles round. As soon as the water has sunk into the ground ploughing commences, and the seed is sown. Millet is always sown, and occasionally indigo, but the hill torrents usually come down so late that the cultivation of the latter is generally impossible.

While the seed is growing, the Balochis are employed in looking after their horses in the hills, a very favourite occupation. All colts are killed as soon as born, unless there is some chance of their being sold in India; the reason for killing them is that they cannot be taken on a marauding expedition, owing to their neighing on seeing a mare. An old saying amongst the Balochis is, "A man who has a saddle on an ass has a saddle on a horse, and a man who has a saddle on a horse has a saddle on his head." If a horse neighs, the rider will certainly be discovered and killed. For ordinary purposes the Khetrân horse is best, but the Mazâri is the best for racing. A mare is ridden from two to three years old, but from three to four seldom; she is allowed a year's rest, and at five is again ridden. I have known mares travel a distance of seventy-five miles in a day, at a quick amble, varied by a gallop.

The saddle in use is the Persian with the peak in front, but it has its advantages; the rider cannot be thrown, he can stand up in the stirrups and fire his matchlock, and can use his sword. To a European the saddle is torture, being too narrow in the seat behind th pommel, but to an Oriental it is perfection.

Sheep and goats are bred in large quantitie the shepherd or "Shafankh," receiving as hi wages 1-8th up to 1-12th of the young reare in the year, this is called "Dror; and a mone payment of 6 to 11 rupees per annum; this i called "Lûmar." An agricultural laboure receives as his wages one-eighth of the pro duce, and nothing more.

Marauding expeditions will now be briefl touched upon, and then, to finish up, ordeal by fire, folklore, and omens.

A marauding expedition is, or used to be, monthly occurrence, and its numbers var from 10 to 300, seldom more, but so great i the competition for places in it, that lots ar drawn for the spies first, and afterwards fo the main body. To select the spies, an opera tion is gone through termed "Tirdah Khanagh," *i.e.*, to draw lots, which is done as follows:— Suppose there are three men out of whom on has to be taken for a spy; they take thre pieces of dung, and each marks his own; a outsider then comes and, taking them u shakes them in his hands, and the first tha comes out is that of the man selected, wh is termed the "Tirdar." If, on the othe hand a man is required to go on an errand fo his chief, an unpopular piece of work, th same process is resorted to, but with pieces wood not dung, and the last piece that come out is that of the man who has to go, he i termed the "Pâsâgh."

After selecting the spies, they are despatche to spy out the country, and to make an est mate of the number of men required for the ex pedition, and this having been completed th commissariat is arranged for. Sheep a killed some distance outside the village an cut up, these are divided by the system drawing lots again, but the man who shake up the lots in his hand is blindfolded, and ha to throw each piece of wood on to a piece meat; each man knowing his piece of wood once takes the meat on which it has falle This distribution is called "Sajji." Th sheep killed for provisions are returned to th Donors, when the expedition has return with the spoil.

The day having been fixed, the band (Dun get ready and start after sunset, marchin about 30 miles the first night, and halting dawn. During the day they lie concealed the jungle, never remaining where they ha eaten food, and always burying the ashes, they have had a fire, which must be lit in

ave, never outside. Avoiding every beaten ack they divide into parties as they go along, nd unite on the last night before attacking. Unless the opposing side shows fight at once hey do not remain to fight, but hurry off with heir booty, travelling for three days and nights hen there is no chance of pursuit. On returning to their tribe distribution is made of he spoils taken, of which one-fifth is first taken ut for the chief of the tribes called "Tumhandar." This being done, shares are portioned out somewhat as follows, a man mounted ets one share for himself and one for his hare, and fractional shares for his matchlock nd sword, and so on.

While engaged in these expeditions, they teer their course by the stars, of which Orion "Tîrband" and the Pleiades "Muchenpaur" re the favourites, and a Baloch knows their position exactly, every month. While on the ubject of the stars, I may mention that they call the four stars of the "Great Bear" "Khât-phâdhagh," or the legs of the bedtead, and the three respectively, the ram "Gurâna," the dog "Bing," and the wolf "Gurkh," of which the dog is chasing the am, and the wolf the dog. In the Panjab hey are called "Palang panw," which means he same as in Balochi, and in Urdu the name s "Sat sahelion ka jhamka," the group of even maidens.

Ordeal by fire is firmly believed in as the most efficacious way of getting at the truth, nd especially of discovering a thief. The irst given is from Panjab "Notes and Queries," nd from which escape is possible, even hough guilty. The remaining three admit of no escape, except by absolute acknowledgement of guilt. In those three cases, the Balochis say, that the guilty person confesses ather than undergo the ordeal.

Taking the first, the procedure is as ollows:—A shallow pit is dug and filled with burning wood, over which the suspected person has to walk. It is possible to avoid being burnt by shaping the oath so that it shall not be a iteral falsehood. There is a story of a king's concubine, who was suspected of infidelity and ordered to undergo the fire ordeal, she was eally guilty, but her lover saved her by tratagem. He, disguised as a madman, ushed up and threw his arms round her as he approached the fire, calling out, "What! s the king going to burn such a beauty?" She mmediately perceived how she should act, and aid, "I swear that no man has ever embraced ne except the king and this madman. If I speak false, may the fire burn me." As this was not absolutely a false statement, she went through the fire scatheless, but she would certainly have been burnt had she merely declared her innocence.

The other three are made use of to discover a thief. For the first, get a spade, and put it on the top of a heaped up fire about three feet high; as soon as it is red, the supposed thief is told to pick out the spade on the palm of his hand, and walk seven paces away and seven paces back again; if then his hands are not burnt he is innocent, if they are burnt he is guilty.

For the second: in a trench 2 feet deep and 10 feet long, wood is placed level with the ground, and set on fire; as soon as it is reduced to red embers, the suspected has to walk along it barefoot, and if he can do it without burning his feet he is innocent, if otherwise he is guilty.

For the third: in a large vessel filled with water, two stones of different colours are placed and it is agreed beforehand, which means guilt and which innocence. A fire is lit under the vessel, and when the water is scalding hot, the suspected person has to bare his arm and pick out a stone. If his arm is burnt and he can't pick out either, he is guilty, the same being the case, if he picks out the wrong stone.

The Balochis are very fond of riddles and proverbs all of which are in rhyme; some of those I quote have been given before by Mr. Longworth Dames, and I merely enter them here, so as to get a collection for future reference. Those quoted previously are placed first.

1. "Dânkî shâhâ parwaren khaptha man logh bunâ,
Nî ki bandaghân razentha, bîtha pha husn o pharân,
Wash hadith o khush lisân,
Roth go phulen ambalân."

the translation of which is,

"As long as God had charge of him he lay at home,
Now that men have made him up, he is fresh and fair,
With sweet conversation and pleasant speech
He walks with his joyful companions."

Answer: A man with a wooden leg.

2. "Khane litr o phiren zâl."
Warnâ sârâ sâr-bâr."

"Old shoes and an old wife.
Are the burden of a young man's life."

3. "Khatân sokhta âfâ phûki wârth."

"One burnt with hot milk will not even drink water without blowing on it."

This, in English, is "A burnt child dreads the fire," or, in Greek, "παθήματα μαθήματα,"

"A misfortune is a lesson."

This also corresponds with the Hindu proverb, "Dudh ka jâlyâ chanchh hî pîwat phunk."

4. "Do gohârân dîtha ambâzi,
Ajab khush ant gwar ambâzi,
Nainî suratâ khami,
Yake khor dighar chami."

"I saw two sisters embracing,
Overjoyed at the embrace,
There is no difference in their appearance.
One is blind, and the other has eyes."

Answer: The reflection in a mirror.

All the above have been quoted by Mr. Longworth Dames, but the following has, I think, never been published.

1. "Langen âsaka drik dâtha wat Allah."

"The lame deer has leapt; God is his friend."

A number of deer were standing together and saying, "As soon as rain comes we will go to fresh pastures daily; the lame deer says he can only leap and trust to God." The Baloch says that he is the lame deer, and the Hindu money-lender the sound one.

2. "Bâzen mar hudhai bachh en."

"Many men are God's children."

This means that if you go to fight with plenty of men you are sure to win the day.

3. "Gwhahar na zânt Mir Châkur en
Bur de kharâni âtarân."

Mir Chakur never felt the cold; but one night he did so, and asked for warm clothes; but when they said to him they had none, he replied, "Place over me an ass's pack-saddle."

4. "Jowâin-nî-en jhangâni badhen boli,
Khai wathi mâl o marduma roli."

"It is not good to hear a bad report of a fight,
And that all the men and cattle have fled elsewhere."

5. "Jîwan Shaikânia pat marna khutha."

"Jîwan Shaikânia has given a funeral feast to 'trust.'"

Jîwan Shaikânia had a servant who robbed him of everything; he was so disgusted at this that he called all his friends together t funeral feast. On their enquiring as to t reason for the feast, he replied, "That, as trust in man was now dead; he gave it funeral feast."

6. "Tobâhen Shâhî Bâlâchârâ azh ro nermosh jhangâ."

"I swear by Shâhi Bâlâch that I w fight from morn till night."

This man is said to have killed every m with whom he fought. When he got old, took eight or ten men and went out to fight army, and returned alone, having killed all them and lost all his own men. This oath taken by every Baloch when he wishes succeed in any work or fight.

7. "Phonz mushaghen gozhdâ warun."

"My nose is itching, I shall eat meat.'

If your nose itches and you promptly scrat it (Khaiga Deagh) then you will eat meat.

8. "Do birâs saimi lekho."

"Two brothers; the third is the reckon'ng.'

When two brothers quarrel over proper left to them, they make up a reckoning, a each keeping a copy, make it a brother."

9. "Bukho main warnâ bukho main beli.
Gind nasîbârâ thângurâ telî."

"Where are my young people, where a my friends,
See it is my fate, whither am I going

This is said by a dead man to himself.

10. "Phîrî kaithen, wahâren gon-en-î.

"An old man comes and all bad wi him."

This means, that when a man gets old can see no good in anything which he admir when young, and that he does not care f things as he did.

11. "Mâlâ sardai vâra dosh."

"Send away the cattle and milk t hedge."

This refers to a bee's nest. You drive the bees and then take the honey.

12. "Halk ladî dem phadhenî."

"The camp is marching, but his face backward."

This is applied to a gun resting on t shoulder with the muzzle backward.

13. "Bakhîlen sâhiben khas na'shi jowain

"A hot-tempered ruler none conside good."

14. "Gokh dhikkî ror phadâth."

"When the cow lows, the calf will run (to it)."

This refers to the bullet flying from a gun hen discharged.

15. "Hor nishân dund o muzh en,
Miragh nishân garmen thaf en."

"Rain clouds are a collection of white vapour,
A sign of death is a hot fever."

16. When Sirdâr Jamâl Khan was taken a isoner to Lahore to Sir Robert Sandeman, r some money matters in which he was nplicated, the Balochis of the Leghari tribe ade the following :—

"Main Sirdâr relâ biyâr,
Sandeman phâdh nelân bâ."

"Bring my chief back by train,
Leave Sandeman's feet in the stocks."

"Horâ jhur raghâm en,
Sandeman topi gijhâni kudhâm en."

"Rain clouds are a collection of vapour.
Sandeman's helmet is a white kite's nest."

This latter is rather a bitter one, as the hite kite is a well-known scavenger, and ves on offal of all kinds.

A Baloch firmly believes in omens; he will ever kill a spider, but the reasons for this I ever discovered; he will always kill a black nake as being an enemy of his religion; if he ees a shrike (Giyânch), or a lizard (Go), when oing on a journey he will return home. It unlucky to give away money on Sundays; Hindus in the Derajat (country across the ndus) will not even pay wages. You should ever travel anywhere on a Wednesday, it held to be unlucky. If an owl hoots at ight it is lucky; if you hear one hooting in a urial-ground, you will die soon. The same lea prevails in England and the Punjab. If fly gets into your mouth, it is a sign that ou will get something to eat. When going n a journey if you meet a woman after starting before anyone else, it means failure in our object. It is lucky to meet a man first. he neighing of a horse or male ass is lucky. is unlucky to hear a jackal barking instead f howling.

A mode of augury often employed before arting on a journey is to kick off the shoes hile walking along; if they fall on the sole is good, but, if they turn over, it is bad. his is common in the Punjab. On certain ays he won't go in certain directions, and this is the case in the Panjab, but the direction is altered.

With the Baloch we have :—

"Yak yâzhdah jâhla wâr ne,
Pânch phânzdah burzâ wâr ne,
Sai senzdah lammâ wâr ne,
Hapt havdah ubhoâ wâr ne."

the translation of which is :—

"On the 1st and 11th I will not go East,
On the 5th and 15th I will not go West,
On the 3rd and 13th I will not go South,
On the 7th and 17th I will not go North."

Compare this with the custom in the Panjab :—

"On Saturday and Monday you should not go East; on Friday or Sunday you should not go West; on Tuesday or Wednesday you should not go North; and on Thursday you should not go South."

The Hindu points of the compass are "Uttar" for the North, meaning high; in Balochi the East "Burza" is high, because it is the mountain side of their country. "Uttar" in Sanskrit means good and pure, and is applied to the North, as being the home of the gods, and every stream coming from the Himalayas, has the sanctity of the Ganges. "Uttar" probably came to mean high as referring to the height of the Himalayas. The Hindus have no left and right for the North and South, as the former term is ill-omened and could not therefore be applied to any place so sacred as the Himalayas.

With the Afghans we have the use of the left and right. The North is "Khai khwa," or the right side; the South is "Kinr khwa" or the left side, so called from the fact of the Moslem worshippers turning to Mecca to say their prayers. The West is called "Quibla khwa" or the side of Qibla, *i.e.*, Mecca. The Hindus worship towards the East, in accordance with the teachings of the Vedas; they turn to the West in the evening. On the South are the demons (Rakshasas) and this they only face while dining or offering cakes to the "Manes." If I remember rightly the Vedas permit of the Hindu turning to the North to say his prayers, as well as to the East.

This paper will close with a few words on "Auguries from Goats."

The Balochis augur coming events from goats, by examining the lines on the shoulder-blade (*bardast*) of a newly killed goat. These were explained to me, but I regret I do not remember them. In such cases the Ramâlî, or professional soothsayers are employed. Goats

are made use of in finding out the position of a disused well which has become overgrown with jungle. It is said that a flock of oats will lie down over the spot in a circle. This method is universally believed in, all over the Panjab; it is not entirely a Baloch custom.

Again, in the Panjab, if two parties quarrel, and one of them wishes to make it up, the latter sends a goat to the house of the former, and if the former accepts it (which he invariably does), the quarrel is at an end. I believe that the Balochis have adopted this custom, but am not quite certain. If they have, it is borrowed from the Panjab.

In the large arid plain below the hills, many Balochis do a little cultivation, but generally retire to the mountains as soon as the hot season commences. Their departure is hastened from fear of a hot wind which occasionally blows, called "jhallâ," and from the effects of which few escape, as it dries up the body. The remedy employed is eating onions, which is said to effect a cure, and is always prescribed by the native Hakîms. The mirages to be seen at the commencement of the hot weather are very beautiful. I have seen the reflection of the Rajanpur cantonment in the sky quite distinctly, with all its avenues of trees and buildings.

On the "Jhuts," who live in this plain, the Balochis have composed the following rhyme:—

"Dehâ avr sohren,
Phîmâz naghan boren."

"His country is all barren,
He eats onions with his bread."

This alludes to the custom the Jhuts have of incessantly eating onions.

In the glossary of the Multâni language, published by Mr. O'Brien, he gives a Jhut proverb, the translation of which is—

"You can always tell a Jhut because he stinks of onions."

"He uses a Thruâ (mat) for a pocket handkerchief."

The grass mat referred to, is that with which they roof their huts in the jungle, and the Jhut uses a large coarse piece of cloth to wipe his nose, of proportionate dimensions.

In the plains at the foot of the hills, the Baloch shepherd need have little fear of being molested; but such is not the case on the mountains. They go out for a week at a time with the flocks, taking with them a bag of flour and a small mussak of water. A muss is a small goatskin, and holds very lit perhaps two gallons, and this they carry their shoulder. It is in order to get at t flour and water that they are very often m dered. They carry also a small flute, whi they play at intervals, and always bef moving they play it; the sheep and go following them as soon as they hear it. It this playing that allows marauders to find their position. A few lumps of sugar generally carried to slake their thirst, and placing one of these in their mouths, saliva formed, and keeps the mouth moist.

A plan adopted in Australia to allay thirst to grease the lips with a piece of mutton f this I recommended to the Balochis, w seemed much struck with the idea.

While out grazing the flocks, one m invariably stands on the hillside to keep wat while the rest are in the valley. When t man on the hill wishes to speak to those belo he first of all calls attention by shouting, a then shouts all he has to say. Those bel immediately place their ear against the hi and catch all by the echo, as it is impossil to hear direct. On one occasion a Balo told me how he played a trick on a shephe in return for a real or supposed injury. took another man with him and stalked t shepherd, caught him, and bound him. Th then killed a sheep and roasted it, dividing into three portions. He and his comrade their portions, but would not allow the shephe to eat his at the same time. They tied hands behind his back, and his legs to a stal so that he could not move forward; they th placed his meat just out of his reach, w his mouth almost over it, and left him. remained in this position for three days, wh some of the tribe, surprised at his not retur ing, went in search of him, and found h nearly dead.

This is all I have to say on the Balochis a their customs, &c., and I hope that this pa will contribute a little useful information to t already collected. My reason for adding quota now is, that having left India for goo consider that my experience of the Baloc might as well be put in print, if only to h others in their study of this race. Memory treacherous, and mine is no better than t of others, so I trust that this paper will be more interest than if it had never been writt or than one written sometime after I had the country, when much must have been f gotten before it was put in writing.

DISCUSSION.

Sir JAMES LYALL, G.C.I.E., K.C.S.I., said he uld not attempt to review the interesting paper fully, he had not had an opportunity of seeing it before came to the meeting; but he had made certain tes while the paper was being read which might prove some interest. He had served in the Dera Ghazi han district, where the Balochis, of whom Mr. Yates ote resided, and had also ridden through the ad- ent hill country which was now under the Balochi- in agency. He was glad to see that Mr. Yates re- gnised the difference between the Balochis and the thans. There was a distinct difference between em, even when they were living alongside each her. The non-recognition by some high officers in dia of this difference had sometimes caused trouble d disappointment, and he was not sure that it was t going to do so again in the northern part of the ntier. The Pathans are of a fanatical Puritanic irit in the matter of religion, and of an extremely mocratic and republican spirit in tribal and political itters, whereas the Balochis, on the contrary, have feeling of loyalty to their tribal chief, much like at of the old Highlanders of Scotland; and a par- ularly liberal, not to say a lax spirit in religion. hen he was employed among them, he remem- red hearing several common sayings or stories ich were proof of this fact. For example, to ll a man a haunter of mosques was a term contempt among them. Again, a young lochi, upon being asked why he did not at- nd the ordinary prayers of the day, stated, "My ief prays for the whole tribe." With regard to the tement in the paper as to the refusal of the lochis to enlist in the army being due to the en- tment of various classes into a regiment, he knew at, after the mutiny, the principle, as a general le, was adopted of having mixed regiments; but did not think that was the reason why the lochis would not enlist. The fact was they were a free and lazy disposition, and had a great ea of their own ways in dress, life, and sur- undings, and all these things were in the way their enlistment. Moreover, they were not over- owded or short of means of subsistence as the thans were. It was true that the Balochis were ry kind to women. He had often heard them ast that in their tribal raids they never killed captured women, whereas the Pathans did. *propos* of what Mr. Yates had said with reference their only riding the mares and killing the foals, it s a curious custom that when they went on a foray, ey always dismounted to fight; they hobbled their rses, and then fought with sword and buckler. lthough the Balochis of this part of the country ere good fighting men, and accustomed to ride rses, the idea of fighting on horseback would be posed to all their ideas, and if caught by a regiment cavalry they would be utterly powerless. Though they were so easy in the matter of religion, they were superstitious and servile in showing respect to certain families descended from some reputed saint or religious teacher. He remembered asking a Balochi how it was *he* showed such extraordinary religious respect to one of these saints, for he knew that the man they were speaking about was one of the greatest rascals in the country, but the reply given was that that did not affect his sanctity, which was hereditary. He (Sir James) asked to how many generations it was supposed this sanctity would be transmitted without being reinforced by any personal piety or sanctity among the descendants, and the reply was that it would go to at least seven generations.

Mr. J. A. BAINES, C.S.I., said his slight acquaintance with the Balochis was confined to those in another part of the country, and from what he had heard there seemed to be a great difference between the Balochis in the north and the Balochis in the south. Those in the plains were more deteriorated in both *morale* and physique than those who remained in the mountains. The apology which Mr. Yates had made in the concluding part of his paper for putting these remarks before them was not at all necessary, because it was only by means of these collections of individual observations that they were able to get information about the different varieties of races in India. Notes of the kind which they had heard that evening, particularly on folk-lore, were very useful, as showing general traditions under local variation. The question of omens which had been dealt with in a very interesting manner was a good example. The observations of Mr. Yates fully confirmed what they knew of the superstitions in other parts of India; for instance, as to the remarks about the Hindu points of the compass, it was well known that the sacred point of the compass was the north, while Mussulmans turned to Mecca. As to the moral character of the Balochis, it was alleged by nearly every half-civilised nation that before they settled down they had the greatest regard for truth, but in the process of civilisation this regard had been obliterated. The fact is, they had not the interests before which made it worth while to lie. As soon as they got to a position of moderate prosperity, and instead of being wanderers had fixed dwelling places, they found it worth their while to resort to the ways of civilisation, which included litigation. There was an historical authority for the veracity of the Balochis, assuming that they did not come from the north within the last 300 years; for Arrian, writing about Alexander, stated that the people of India never told lies. He was inclined to look upon the Syrian origin of the Balochi race as a late myth.

Mr. C. A. FOX said he thought they must credit the Balochis with having a real love of truth. It was

well known that civilisation had produced pernicious effects on many races. Only a few nights ago, he attended a lecture in that room when he heard that it was doing a great deal towards injuring Japanese art. They wrought *con amore* before. We knew it was always a difficult matter to get a genuine article or one thoroughly well made; people said they could no longer be obtained, as manufacturers would not produce them. He recollected it being stated that a Bishop recently spent a large sum in order to have a book bound according to olden times; the bookbinders said it was not that the art had been lost, but that customers would not pay sufficient to make it worth while to do the work properly. The same thing applied to the building of houses and making furniture. In some places, especially in Pitcairn Island, the natives had not yet been injured by the spread of civilisation, but how long this would last he could not say. He noticed in the paper a statement that a Balochi to be respected must have long, black, curly hair, and it was remarkable that even among us judges wore wigs, which he supposed was to make them respected. The Balochis were well known for their hospitality, and respect for the property of others. The same thing might be seen in other places where civilisation had not advanced with its evils as well as its good.

The CHAIRMAN, in proposing a vote of thanks to Mr. Yates, said they were all much obliged to Sir James Lyall and Mr. Baines for their remarks on the paper. He had really no criticisms of his own of an exegetical character to make on the paper just read by Mr. Yates. He quite agreed with Mr. Baines that it was impossible to accept the story of their origin given by the Baluchis themselves. The question was full of interest, both in connection with the pre-Aryan peopling of India and the rise of civilisation in the valleys of the Nile, and Tigris, and Euphrates, and its diffusion from these primæval centres of its initiation over Southern Europe and Central and Southern Asia. But we had scarcely as yet arrived at the beginning of the solution of the intricate problem of the origin of the Baluchis, although it had long been profoundly discussed both in France and Germany. The assumed natural truthfulness of the Baluchis had been far too seriously accepted both by Mr. Baines and Dr. Fox. He was orthodox enough to believe that all men were liars, even the undegenerate Baluchis of the period before the British conquest of India. But of the merits of the paper generally, he would say that it was as valuable as it was interesting. It was a real addition to our knowledge of the people of Baluchistan, and would enhance the reputation already enjoyed by Mr. Yates as a special authority on the Baluchis. The Chairman then moved the best thanks of the meeting to the Society, which was carried unanimously.

MEETINGS FOR THE ENSUING WEE

MONDAY, JUNE 17...Geographical, University of Lond Burlington-gardens, W., 8½ p.m.

TUESDAY, JUNE 18...Statistical, Royal United Service In tution, Whitehall, S.W., 5 p.m. Mr. James E Robertson, "Some Statistics bearing upon metallism."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. J. Graham Kerr, "Some Points in the Anatom *Nautilus pompilius*." 2. Messrr. F. E. Bedd and A. C. Haddon, "The Nudibranchiate Mollu collected by Prof. Haddon in Torres Straits." Mr. G. A. Boulenger, "A Collection of Fis from the Rio Paraguay."

WEDNESDAY, JUNE 19...SOCIETY OF ARTS, 9 p.m. C versazione at the South Kensington Museum.

Meteorological, 12, Great George-street, S.W., p.m. 1. Mr. Richard H. Curtis, "Hourly Va tion of Sunshine at Seven Stations in the Bri Isles." 2. Mr. Henry Harries, "The Frequen Size, and Distribution of Hail at Sea."

Geological, Burlington-house, W., 8 p.m. 1. Mes William Hill and A. J. Jukes-Browne, " Occurrence of Radiolaria in Chalk." 2. Mr. W. Lamplugh, "The Crush-Conglomerate of Isle of Man." 3. Sir Henry H. Howorth, " Chalky Clay of the Fenland and its borders: Constitution, Origin, and Distribution." 4. T. Crosbie Cantrill, "The Occurrence of *Spirors* limestone and thin Coals in the so-called Perm Rocks of Wyre Forest; with Considerations the Systematic Position of the Permians of Sa pian Type."

THURSDAY, JUNE 20...SOCIETY OF ARTS, John-str Adelphi, W.C., 3 p.m. Conference on Techni Education.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mess William and G. S. West, "Some North Americ *Desmidieæ*." 2. Mr. A. Vaughan Jennings, " Structure of the Isopod Genus Ourozeukt Milne-Edw." 3. Mr. F. N. Williams, "A Revis of the Genus *Silene*." 4. Mr. E. R. Waite, " Egg-cases of Port Jackson Sharks."

Chemical, Burlington-house, W., 8 p.m. 1. Mess Horace T. Brown and G. H. Morris, "Lintne Isomaltose." 2. Prof. Walker and Mr. T. Hamley, "Transformation of Ammonium Cyan into Urea." 3. Mr. A. C. Chapman, "Some deri tives of Humulene." 4. Miss Walter, "Note Thio-Derivatives of Sulphanilic Acid." 5. Dr. P. Wynne and Mr. A. Greaves, (i.) "The Chlori tion of Orthochlorotoluene;" (ii.) "The Six chlorotoluenes." 6. Dr. W. P. Wynne and M T. Bruce, "The Disulphonic Acids of Toluene a of Ortho- and Parachlrotoluene." 7. Prof Wall and Mr. J. R. Appleyard, "Ethereal Salts Ethanetetracarboxylic Acid." 8. Mr. H. R. Hi and Prof. J. B. Cohen, (i.) "A Method for prep ing Formyl Derivatives of Aromatic Amines (ii.) A Modification of Zincke's Reaction." Mr. W. H. Archdeacon and Prof. J. B. Coh "A new Method of preparing Cyanuric Acid."

Historical, 20, Hanover-square, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p Annual Meeting.

FRIDAY, JUNE 21...Quekett Microscopical Club, Hanover-square, W.C., 8 p.m.

Journal of the Society of Arts.

No. 2,222. Vol. XLIII.

FRIDAY, JUNE 21, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with Sec. 40 of the Society's Bye-laws :—

TREASURERS' STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING MAY 31ST, 1895.

Dr.

	£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1894	917	19	11			
Do. in hands of Secretary	23	15	9			
				941	15	8
,, Subscriptions	5,258	19	0			
,, Life compositions	294	0	0			
				5,552	19	0
,, Dividends and Interest				806	0	3
,, Sale of Consols for re-investment in Freehold Ground Rents				10,443	14	0
,, Ground Rents				318	3	9
,, Examination Fees and Programmes				806	4	5
,, Donations to Examination Prize Fund :—						
Clothworkers' Company	30	0	0			
Goldsmiths' Company	25	0	0			
Merchant Taylors' Company	10	10	0			
Salters' Company	5	5	0			
Skinners' Company	5	5	0			
				76	0	0
,, Conversazione, 1894 (sale of tickets)				129	17	6
,, Advertisements				823	15	11
,, Sales, &c. :—						
Cantor Lectures	25	15	11			
Fees for use of meeting-room	33	12	0			
Journal	134	5	0			
Spoiled Postcards	1	8	0			
				195	0	11
				£20,093	11	5

Cr.

	£	s.	d.	£	s.	d.
By House :—						
Rent, Rates, and Taxes	392	18	8			
Insurance, Gas, Coal, House expenses and charges incidental to meetings	278	1	4			
Repairs and Alterations	443	1	4			
				1,114	1	4
,, Office :—						
Salaries and Wages	2,161	2	3			
Stationery, Office Printing, and Lithography	325	8	5			
Advertising	89	8	6			
Postage Stamps, Messengers' Fares, and Parcels	220	4	7			
				2,796	3	0
,, Library, Bookbinding, &c				62	1	1
,, Conversazione (1894)				607	18	5
,, *Journal*, including Printing and Publishing				2,162	1	6
,, Advertisements (Agents and Printing)				411	18	9
,, Examinations				768	17	8
,, Medals :—						
Albert	22	11	0			
Society's	27	19	0			
				50	10	0
,, Drawing Society Prizes (1894 and 1895)				22	4	0
,, Owen Jones Prizes				5	11	0
,, Prizes for Designs for Swiney Cup				23	2	0
,, Cantor Lectures				252	10	5
,, Juvenile Lectures				22	17	11
,, Sections :—						
Applied Art	61	4	0			
Foreign and Colonial	62	12	9			
Indian	71	4	0			
				195	0	9
,, Committees (General Expenses)				11	16	3
,, Interest on Trust Funds placed on Deposit				100	0	0
,, Investment in Ground Rents				9,979	4	0
				18,585	18	10
,, Cash in hands of Messrs. Coutts and Co., May 31st, 1895	1,481	6	0			
Do. in hands of Secretary	26	6	7			
				1,507	12	7
				£20,093	11	5

Liabilities.

	£	s.	d.	£	s.	d.
To Accounts due	542	14	3			
,, Examiners' Fees	339	3	0			
,, Examination Prizes and Medals	70	0	0			
,, Examination Prize Fund	20	15	0			
,, Photogravure Prizes	34	6	0			
,, Liabilities on purchase of Ground Rents, and Balance from sale of Consols	464	10	0			
,, Sections:—Applied Art, Foreign and Colonial, and Indian	190	0	0			
,, Accumulation under Trusts	425	19	0			
				2,087	7	3
Excess of Assets over Liabilities				19,249	7	2
				£21,336	14	5

Assets.

	£	s.	d.	£	s.	(
By Society's Funds invested in—						
£1,542 12s. Consols, estimated at	1,500	0	0			
£500 Canada 4 per Cent. Stock, estimated at	525	0	0			
£500 South Australia 4 per Cent. Stock, estimated at	525	0	0			
£530 10s. 1d. New South Wales 3½ per Cent. Stock, estimated at	530	0	0			
£500 New South Wales 4 per Cent. Stock, estimated at	525	0	0			
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock, estimated at	280	0	0			
£1,500 Queensland 4 per Cent. Bonds, estimated at	1,550	0	0			
£500 Natal 4 per Cent. Stock, estimated at	550	0	0			
Ground Rents	10,496	2	9			
				16,481	2	
,, Subscriptions of the year uncollected	510	6	0			
,, Arrears, estimated as recoverable	214	0	0			
				724	6	
,, Property of the Society (Books, Pictures, &c.)				1,800	0	
,, Advertisements on the Books, due, and in course of execution*				423	13	
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1895				1,481	6	
,, Do. on Deposit (interest on Trusts)				400	0	
,, Do. in hands of Secretary				26	6	
				£21,336	14	

* A portion of this sum is subject to charges for printing.

Investments, &c., Standing in the Name of the Society.

	£	s.	d.
Ground Rents	£17,669	4	0
Consols	3,146	12	3
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500	0	0
Bombay and Baroda Railway 5 per Cent. Guaranteed Stock	2,450	0	0
Canada 4 per Cent. Stock	923	0	0
South Australia 4 per Cent. Stock	605	16	0
New South Wales 3½ per Cent. Stock	530	10	1
New South Wales 4 per Cent. Stock	500	0	0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Bonds	1,500	0	0
Natal 4 per Cent. Stock	500	0	0
Cash on Deposit with Messrs. Coutts and Co.	400	0	0

Trust Funds Included in the Above.

		£	s.	d.	
1.	Dr. Swiney's Bequest	£4,500	0	0	Invested in Ground-rents (£4,477 10 0), and chargeable with sum of £200 once in five years.
2.	John Stock Trust	100	0	0	Consols, chargeable with the Award of a Medal.
3.	Benjamin Shaw Trust for Industrial Hygiene Prize	133	6	8	,, ,, ,, of Interest as a Money Priz
4.	North London Exhibition Trust	192	2	1	,, ,, ,, ,,
5.	Fothergill Trust	388	1	4	,, ,, ,, of a Medal.
6.	J. Murray, in aid of a Building Fund	54	18	0	,,
7.	Subscription to an Endowment Fund	562	2	2	,,
8.	Dr. Aldred's Bequest	173	10	0	,, chargeable with the Award of a Prize.
9.	Thomas Howard's Bequest	500	0	0	Metropolitan Railway 4 per Cent. Perpetual Preference Stoc chargeable with the Award of a Prize for an Essay.
10.	Dr. Cantor's Bequest	4,600	0	0	Bombay and Baroda Railway Stock, as above, and Groun rents (£2,695 11 3). Interest applied to the Cant Lectures.
11.	Owen Jones's Memorial Trust	423	0	0	Canada 4 per Cent. Stock, charged with the award of Prizes Art Students.
12.	Mulready Trust	105	16	0	South Australia 4 per Cent. Stock, the Interest to be appli to keeping Monument in repair and occasional Prizes Art Students.
13.	Alfred Davis's Bequest	1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guarante Debenture Stock. Interest at the disposal of t Council for promoting the objects of the Society.
14.	Accumulated Interest on Trust Funds	400	0	0	On Deposit with Messrs. Coutts and Co.

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

B. Francis Cobb, }
Owen Roberts. } *Treasurers.*

J. O. Chadwick & Son, *Auditors.*

Henry Trueman Wood, *Secretary.*

Society's House, Adelphi, 19th June, 1895.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One undred and Forty-first Annual General Meetig for the purpose of receiving the Council's eport and the Treasurers' Statement of ceipts, payments, and expenditure during ie past year, and also for the election of ficers and new members, will be held in cordance with the Bye-laws, on Wednesday, th June, at 4 p.m.

(By order of the Council)
HENRY TRUEMAN WOOD,
Secretary.

CONVERSAZIONE.

The Society's annual *conversazione* was held the South Kensington Museum (by perission of the Lords of the Committee of ouncil on Education), on Wednesday, 19th st., and was attended by 2,208 visitors.

The reception was held by Major-General r John Donnelly, K.C.B., Vice-President id Chairman of the Council, and the followg Vice-Presidents and Members of Council: -Captain W. de W. Abney, C.B., F.R.S., ohn Wolfe Barry, C.B., Lord Belhaven and tenton, Sir Frederick Bramwell, Bart., D.C.L., .R.S., George L. Bristow, Sir George Hayter hubb, Francis Cobb, Sir Charles Malcolm ennedy, K.C.M.G., C.B., Sir Westby B. erceval, K.C.M.G., William Henry Preece, .B., F.R.S., and Sir Owen Roberts.

Promenade Concerts were given by the Band the Royal Artillery (conductor, Cavaliere . Zavertal), in the North Court, and by the ed Band (conductor, Mr. Poole), in the extiles Court of the Museum.

A Glee and Madrigal Concert was given at tervals, by Mr. Stanley Smith's Part Singers, the Lecture Theatre.

A Vocal and Instrumental Concert was given the Royal Criterion Hand-bell Ringers and lee Singers (under the direction of Mr. Harry ipper) in the East Architectural Court.

TECHNICAL EDUCATION CONFERENCE.

The Conference of representatives of the echnical Instruction Committees of the rious County Councils, and others intersted in the subject, was held yesterday afteroon (20th inst.), Major-General Sir JOHN DONNELLY, Chairman of the Council, in the chair.

The report of the discussion will be printed in a future number of the *Journal*.

TEN-VOLUME INDEX TO "JOURNAL."

The new Index to the *Journal of the Society of Arts*, for volumes xxxi. to xl. (1882-1892), is now ready, and can be obtained by members on application to the Secretary, John-street, Adelphi.

Some copies of the three previous ten-volume Indexes are still in stock, and can also be obtained by members on application.

The price to non-members of each Index is Half-a-crown.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 28; the VERY REV. the DEAN of ST. PAUL'S, in the chair.

The paper read was—

THE DECORATION OF ST. PAUL'S.

By PROFESSOR W. B. RICHMOND, A.R.A.

When I was asked to read a paper before the Society of Arts upon mosaic, my first inclination was to decline to do so, because, like all other arts, the art of mosaic is involved with technicalities which, to a mixed audience, can claim but very limited interest. Upon second thoughts, however, it occurred to me that it would be wise to set aside all doubts as to the interest or the reverse of the subject of my discourse, and to remember only the object of it—a noble one at least—the decoration of our great Metropolitan Church of St. Paul.

It will be needless for me to enter into an historical treatise upon mosaic, though I shall have to say something about its growth and decline, because books provide such information, and, moreover, the historical side of the question was very fully set before us not long ago from this desk.

It is left, then, for me, with as little egotism as possible, to set before you the history of my experience, which has, by this time, become very considerable in a difficult and beautiful art, which, the longer I study, the more enchanting I find its possibilities, and the more ennobling its limitations and restrictions.

It will be impossible to avoid technicalities, which will only commend themselves to experts; they are of necessity dull matter, excepting to those who are more or less craftsmen.

It must be remembered that an artist speaks to you primarily, and almost entirely through his special language of form and colour; his pen may be a useful adjunct, but it will never instil a comprehension of the language of æsthetics unless the artistic sense is already present in the minds of his audience. Colour and form can no more be described in words than notes of music. If eloquence and a mastery of language could have succeeded in making English people an artistic nation the writings of John Ruskin would have done so years ago. We are, in this latter half of the 19th century, in a desperate hurry; life is so complicated, so full, so strenuous, and leisure is so rare, that the arts of peace, which demand quiet and study, have but a slender chance of assuming that importance in our lives which they undoubtedly assumed in simpler and less distracted civilisations. We are, to a certain extent, the slaves of fashion, ever shifting, ever changing, with a rapidity truly appalling, by which restlessness art must suffer more or less, and especially that form of it which is known by the title "momumental."

Monumental art claims no fashion, it is not the result of a moment's exhilaration, it is not the mark of a clique, nor is it the common property of the sale-room, it is essentially non-commercial. To induce a taste for monumental art in England, excepting in a very spasmodic fashion, has always proved to be difficult, indeed, it would appear to be well nigh impossible. It was difficult a century ago, when James Barry painted these walls, whilst he lived mainly upon bread and apples, and Sir Joshua Reynolds was filling the learned with amazement by his profound discourses upon "the grand style," and his eloquent eulogiums upon that greatest of all modern artists, Michael Angelo. The art of Fuseli, Barry, Haydon, and other enthusiasts, left but little mark upon the buildings of England. Tom Thumb, the famous dwarf, attracted crowds, while the collection of pictures by Haydon was visited by ones and twos. The particular constitution of the English mind is practical; its predilections are more Roman than Greek; it is more sensible than poetical, more commercial than imaginative.

The Reformation set a-blaze whole piles of prejudices: the dread of idolatry, the fear l matter should be worshipped in place of spi strangled every artistic effort in the direct of church decoration. Such violent feeli were national, so that when the Bishop London was approached in regard to decoration of St. Paul's a century ago, he only spoke his own feelings, but probably expressed also the feelings of the majo when he made answer to a deputation, "t nothing would induce him to sanction conversion of Protestant St. Paul's into Popish church."

So the "grand style" of Reynolds, Bar Fuseli, and other considerable artists ne came off. Hence our cathedral remained example of the dulness of Protestantism, evidence that England was not ready to marry religion and art, which since the 1 century had been divorced, to the seri detriment of one as of the other.

Time has, however, wrought change in t aspect with which such matters are regard The Oxford movement, greater facilities travel, and a generally broader and health view of religion, and its consequent eman pation from many narrow crudities, have c and all conduced towards a possibility of t reunion of religion and art, which cannot f to promote vitality and reality to both cause

So when the atmosphere of thought w cleared of prejudice and narrowness, it g into the air that St. Paul's Cathedral co not be allowed any longer to remain a stan ing protest against progress, whilst even t Nonconformists were finding that they m travel a bit with the times, and shed some the dull feathers of their mournful pluma and break into song accompanied even by t dreadful instrument, "the devil's box whistles." And so it came to be ag seriously considered that St. Paul's should decorated in an appropriate manner in acco ance with the wish of Sir Christopher Wr and this time there was no veto put upon t enterprise by a narrow-minded prelate.

Once more that precious votive offering man's highest intelligence, and his power create and to dedicate his gifts to Go House, were to be offered in an Anglic Cathedral, and which had been for th centuries almost wholly absorbed by th branch of the Christian church belonging Rome.

That great artist, Alfred Stevens, who monument to Wellington is worthy of t great general, as it is worthy of this natio

nade designs for some of those spaces known is the spandrils, below the great dome of St. Paul's.

Another great artist, happily still with us in he possession of his great faculties, at an idvanced age, George Frederick Watts, designed for two of the spandrils. We now see he result in mosaics executed by Dr. Salviati, of Venice.

Various experiments were tried for the decoration of the choir and the great dome, which, or one reason or another, failed to receive a cordial recognition, notwithstanding the narked ability of Sir Frederick Leighton's and Mr. Poynter's designs; and for a time natters came to a standstill.

The reredos, erected from Messrs. Bodley and Garner's design, demonstrated the absolute necessity for proceeding with the decoration; and it was through Mr. Bodley's advice hat I had the honour of being called in to ender my assistance. And let me here take his opportunity to express my gratitude to my riend, Mr. Bodley, for his having been the irst cause which brought to me a labour that has been, is, and will be, I trust, for some years to come, fraught with the highest pleasure and deepest satisfaction, which entirely outweigh the anxieties and responsibilities of my work. And this is a fitting ime and opportunity for me to record my everlasting obligation to the distinguished Dean who has so kindly taken the chair this evening, and to his colleagues for their touchingly loyal confidence granted to me by one and all of them.

In an undertaking so difficult and so full of possible pitfalls, I must here affirm that it would have been impossible for me to have carried out my work as far as I have done with a comparative sense of ease had not felt at every turn, and under every difficulty, hat I was environed by an atmosphere of sympathy and perfect confidence, which increased my energy and desire to worthily carry out the wishes of my friends. I question f in the whole history of art, any man has been so happily circumstanced as I have been, or ever worked under conditions more favourable to himself.

One more pleasant recognition before I start upon the egotistic track. My thanks are due o Mr. Harry Powell for his unremitting labour o give me what I wanted in the glass tesseræ, as well as in the glass for such windows as I have designed and executed for St. Paul's.

I venture to think that, in all respects, the materials supplied by Messrs. Powell for my work are first-rate, equal, indeed, to any which were supplied to the mosaic artists of the best periods, Greek or Italian.

To my workmen, who I regard as brother artists, both those who assist me in my studio, as well as those who work so carefully and so steadily in the cathedral, I tender my heartfelt thanks. Instead of increasing my difficulties, one and all of my co-workers have aided me unselfishly and kindly.

When the Dean and Chapter desired me to submit designs for the decoration of the choir, I was fully determined upon certain points. That the only material for such decoration was mosaic, because it can be washed without injury, an absolutely necessary precaution under the condition of London smoke-laden atmosphere. However delightful may be the methods of fresco and tempera painting in the clear air of Italy, or even in country places in England, while London air continues to be charged with every destructive acid, they are out of the question there. And, further, the advantage of mosaic over all other material for decoration lies in the free use of gold and silver which is demanded by the nature of the design that is applicable to the material.

Against pictorial mosaic I resolved to set my face, and to adhere to the principles of design and execution which prevailed in Italy, Greece, and Asia Minor during the classical times of the Byzantine Empire. And while adhering in principle to severe methods of design and simplicity of colouring, to accept and make use of the modern spirit of antiquarian research I determined to follow the precepts of the great masters, by being accurate in drawing, and, according to my lights, noble in my choice of form.

But, perhaps, my most important point, as it appeared to me to be, was that our Metropolitan Church must be decorated by English, and not by Italian labour. I am bound to say that if England found herself unable to provide genius and talent for the adornment of her great church, better that it were left alone, to prove once more that we are not an artistic people, but only a race of shopkeepers.

As far as my workmen are concerned, the aphorism of Napoleon has been contradicted. Quite leaving out any estimate of the qualities of my design from the question, of which I am no judge, in fairness it can be said that the mosaic work in St. Paul's, laid by English workmen, the materials for it made in England, proves that, however rash it might

have appeared to be at first sight to employ them, there need be nothing but congratulation as regards the choice.

The workmen under me have proved themselves able to compete with and beat their coworkers upon the continent, a matter of the utmost importance at a time fraught with commercial difficulties, and stagnation in the labour market.

Another point upon which some determination upon my part had to be exercised. Whether from false ideas of economy, or, what is more likely, a certain listlessness, modern mosaic workers have thrown aside the well-tried principles of mosaic manipulation, substituting a method illegitimate, lifeless, and unreal. I allude to the practise of fixing the cubes by means of gum upon canvass away in a workshop, far removed from the building that is to receive them.

That process I will not waste my time in describing. Yet, broadly speaking, one aphorism that applies to all decorative art may be permitted me. "Just as a building is erected where it is to stand, so every portion of the decoration of that building, wherever it has relationship to the walls or to the structure, should be executed where it is to remain, in the light and under the conditions of its environment."

If one lesson can be learned which is absolutely sustained throughout the churches of Italy, it is the important fact that a harmonious spirit seems to pervade these churches of every century's labour, even to the 17th century; because what we see there, from Lombardy to Naples, are conceptions, conceived as a whole, executed as a whole, and, perhaps, carried out unconsciously harmoniously with their surroundings; because they were carried out *in situ*, under the ruling of the dominating influence of architecture.

This being duly considered, I had to look around. It was not unnatural that my first thoughts should travel in the direction of Whitefriars Glass Works, where the Powells have been labouring to improve the manufacture of ornamental glass for more than a century. And I was rewarded.

Mr. Harry Powell, as I have said, took infinite pains to supply me with tesseræ as good in colour as any I have seen; indeed, upon placing them side by side with cubes of Greek and Italian manufacture of the best period of the mosaic art, I am bound to say that they were hardly distinguishable one from the other, either in quality of material or brilliancy of colour.

To start with, I thought a palette of thir colours, or rather shades of colour, was suffic ent, and there I was right; that number much more than sufficient. As my experienc increases, eight or ten tones of colour a ample if used with art and knowledge as their relative action. And this limitation the number of colours is one of the gre powers of mosaic, which I will later on brief explain.

Well, if we were to recede from moder technique, and re-adopt the old style, ho were we to proceed? You know that the are two cements, water and mastic, in whic the cubes are inserted. It is beside our in tention this evening to follow to earth eve detail of my great enterprise, suffice it to sa that, after many experiments, I found mastic cement answering in every detail to cement employed in the 14th century in th restoration of Andrea Tafi's mosaics upon th dome of the baptistry at Florence. Its advan tages are many; it does not dry too rapidly and it retains a certain modicum of elastici for a long period.

Those members of the public who have s generously opened their purses for the decora tion of their cathedral need not fear that tim will prove cruel towards the object of thei donations. My cement in time becomes s hard, and the cubes are so firmly embedde with it, that it may in time be said to be lik stone. Thus one very grave difficulty was wit patience surmounted.

Now came the testing point of my ras promise to obtain English workmen. Again applied to Mr. Powell. Two of his young me had already executed a mosaic panel, after a design of Mr. Holman Hunt's. But as thei work had been entirely the modern pictur mosaic, executed with thin plates of glass in place of cubes, the method which I had determined to employ was to them an entirely new one.

Now, at the outset of my work—seeing tha I was to initiate the recovery of a lost art—much as I desired at once to work upon the wall of the church, upon consideration it appeared to me important that the initiative should be made as easy and convenient as possible, seeing what the difficulties of the problems before us must of necessity be. Therefore, I built in my garden a shed and a studio, the one for my use, the other for the use of the mosaic workers who, as time went on,

gathered strength in numbers, recruited from various sources, till we finally, for the moment, reached nine workers, and here we worked for four months.

If we were not yet to work upon the wall, what were we to do? I had large slabs of slate cut, well scored with diamond shapes, so that the intonaco to be laid upon them would find a grip; and upon these slabs were executed the first two spandril mosaics, those which you can see upon the north side of the sanctuary, above the arch, between the cornice and the capitals. But I must go back a moment. The sketches prepared upon a small scale, the full-sized cartoons were executed. I chose to make my first essays upon the parts of the church lying midway between the vault and the floor, so that they might offer me a fair chance of trying the strengths of light and dark at a comparatively speaking moderate altitude. Thus, I should have a guide for future work, by which I could reason what strength would be required at a greater height. These cartoons I made in charcoal for the following reasons:—I wished not to compromise myself with elaborate colouring at the outset, for I feared that my practice as a painter might lead me, however carefully I guarded against it, to disregard the peculiar nature of the material I had to use; also it would enforce my being present during the whole proceedings, and oblige me to overlook every bit of work, and, in point of fact, to do a great deal of it with my own hands; this I did, not only executing a considerable portion, but also learning how to cut up the material so that I might prove to my own satisfaction what could and could not be done in shaping the cubes. I believe in only four shapes as the result of this experience, namely, the cube, the double cube, the equilateral triangle, and elongated cut forms finishing in sharp points. In order to be exact in the shape of the slabs which had ultimately to be fitted together and to make a perfect joint when fixed, I cut my cartoons up into the necessary number of shapes of such a size that each shape could be given to one or two men to work upon.

I made a rule to begin with the outlines, whether in the flesh or the drapery, of working from the shadow, through the half-tint, and so up to the light. A difficulty sometimes occurred in that as the space became filled up the cement overlapped and pushed the outlines out of shape; this difficulty was easily met by pressure from the outside of the outlines, until they assumed their proper curves. It was no small difficulty, at first, to persuade my workmen to leave a good margin of cement showing between one cube and another, naturally, for the three of my workmen who had had some experience in paper mosaic, two having worked with Messrs. Powell, and one with Salviati, had acquired that evil habit of jamming the cubes closely side by side, thereby quite ruining the legitimate effects of signs of building, so important to mosaic as to architecture, and making, instead of structural design, an indifferent imitation of a picture. I endeavoured to beat into their brains the fact that the worst mosaic is most like a picture, and the best mosaic has all the structural qualities belonging to architecture—the one entirely out of place in a building, while the other seems to grow naturally out of architectural forms. After a time, I found my men taking a keen interest in the work—intelligently—proving, after all, that Englishmen only need to have sound principles taught them, and insisted upon, to render them as serviceable craftsmen as the world can now produce. Upon more than one occasion they have said to me that they no longer felt mosaic work to be monotonous, mechanical, and uninteresting; whereas under the system of cutting the thin slabs of the flash mosaic of Messrs. Powell's into complicated shapes—more complicated than geographical puzzles which we used to put together as children—they wearied of it. I made it a rule never to leave my men in doubt as to my meaning. When I criticised, no work was taken out to be redone without careful explanation why it was done. I drew diagrams to show what I meant as to the simple principles of building the cubes, worked with them, raised the enthusiasm of those who were to be my prime helpers in a most difficult and responsible work.

For more than three—nearer four—months, day by day we worked together. At the end of that time, I am bound to say, that I was much wiser than at the beginning, and I venture to think that all the anger which had exploded and the labour expended during that period were not in vain. I had got my staff into good working trim, as I believe anybody could do, if they would never trust to a middleman, that most fatal invention of modern commerce and successful destroyer of enthusiasm, and consequently of life in work and everything that makes art in immediate touch with our most delicate sympathies. Until that incubus is got rid of, and architects as well as

decorators limit themselves mercilessly to what they can personally oversee, delegating nothing to a subordinate, and are day by day in immediate relation to their craftsmen, there is nothing to expect for the future but death and sterility for art. At last the two spandrils were completed, and carted away to be put up in their place. The wall to receive them was cut back, and the slabs were fixed with bronze screws into leaden sockets inserted into the stone, being bound to the wall with red lead.

And now, with regard to these two spandrils, permit me to be at once frank and brief. I did not use sufficient strength in my outlines —I used my white too liberally—the consequence being that the half-tones are too narrow, on account of the liberal expansion of white. I erred upon the side of light, and neglected broad shades. I hope, however, to have this put right by-and-bye, and I feel sure that the same faults have not again been committed. In the meantime, my men being in full working trim, I resolved to attack the small easternmost dome. This dome, saucer-shaped, happily obliged us to begin to work upon the wall at once, and I thought it a good opportunity to put my men into a position of responsibility, as they had just come out of a severe and personal training.

It was not without some difficulty that I persuaded Messrs. Powell, who had never executed anything in mosaic directly upon a wall, that the principle of paper mosaic was not the best and the cheapest: they imagined that their system was quicker, and therefore more profitable. I, on the contrary, held the opinion that upon the economical question they were wrong, and that I was right; but in order to prove my point, I had an eagle worked upon their principle. They were convinced, not only upon the important point of economy, but, secondarily, upon the result; my principle took about half the time, and was infinitely more satisfactory when done; indeed, the man who after having worked with me, lamented that he should have been employed again to go through the deadening drudgery of the modern system.

It is wonderful how quickly the modern mind is accessible to art when it has once grasped the fact of its relation to profit, but you must indelibly prove the profit before the artistic sense is touched. Whatever may be the results of my work, *qua* design, that I have nothing to do with. I am willing to wait a century for an estimation of its value, but one thing I trust to have done, I trust I have for ever killed paper mosaic in England, fc financial as well as artistic reasons. I hop to have re-established the old plan, which i quicker, cheaper, and better than the new; leads to finer work; it is more certain in it results; it is legitimate in principle, and firs and foremost, it is infinitely more amusing t the workman, for it stands to reason, if th workman is not amused by his work, it will b lifeless, inarticulate, and dead. Drudgery w all have to pass through, but the drudger that is slavish and leaves nothing for spon taneous expression, and which makes th workman into a shackled slave, can be n more humanising to him than it can be inter esting or touching to the minds of those wh review its results.

I have been very careful to retain worl which, while it did not come up to my standar of completeness, displayed at the same tim a vitality and character which I should hav been very sorry to lose. Uniformity of execu tion of such great magnitude would end i dullness without variety of execution, and th faults of its merits that help to give it life.

No better illustration can I think of than th frieze of the Parthenon, evidently the work o one designer, though executed by severa different hands. One recognises the failure o expression here and there among the triumph of perfect successes—the halting incomplete ness by the side of gem-like finish. We fee the pulse of the workman in the touch of failure and the work is human; the shadow, as wel as the light of the human mind, is there: ou sympathies are aroused for the duplex natur of man. A dead level of perfection, a col accuracy of science, and a perfection to b reached only in such a small thing as a Gree gem, would be quite insufferable when ex hibited upon an enormous scale, which natur ally demands the exhibition of many and ver various phases of thought.

For four months we worked upon the dome Before commencing the mosaic, I offered up my charcoal design. Afterwards I coloured it, and again offered up a portion of the coloured cartoon. The first was with the object o ascertaining the strength of outline, the second the strength of colour. As I see my work now completed in mosaics, I see reasons for certain regrets. My cartoons having been executed in pastel, did not receive any reflection upon their surfaces from the nature of the material adopted. The mosaic, however, does receive reflection. The lesson I learnt here was to make my outlines and

asses far more distinct in the cartoon than I tend them to appear when transposed to nother and reflecting medium, because the flecting suface eats into all the dark surces. I also made too many details; in point fact, in a sense, I put in more work than as really needed. Upon the other hand, one ust remember (to compare great things with nall) that Phidias completed every figure upon e pediment of the Parthenon *ad unguem*. ome of the most delicious portions of the ork were for ever hidden from view from e time they left the workshop of Phidias the time when they were taken down by ord Elgin. This, to the commercial mind, labour thrown away, but to the dedicatory irit of the great Greek artist, his labours eant religious offering to the virgin goddess; is sacrifice through his art was to her, he ave her his best, his truest, and noblest elf, disregarding the labour he expended he isregarded applause or blame. Sentiment part, it is my firm conviction that the inuence of delicate details, even upon a height, never wholly lost, it gives a play of colour, mystery, and an interest which breadth lone cannot achieve; it is possible to overdo etail, but it is far worse to underdo it. To verdo breadth, ends in baldness, a far greater n, to my thinking, than an excess in the other irection.

Every portion of a building requires a ifferent treatment, owing, of course, to the anifold effects of light to which surfaces are ubjected. In the case of the dome, it was esirable to heighten it in effect, rather than lower it. A dome we can hardly call it, in at its elevation, at the apex of the curve, is ot more than 3 feet, so that, in point of fact, is more like an inverted saucer than a cup.

As soon as the plaster was stripped and vealed the extremely beautiful brick face—etter brick building I have never seen—I at nce became aware of the heightened appearnce which the concentric circles of the white ortar lines between the courses of bricks ave. Oddly enough I had already designed r the dome upon such principles of conentrating circles—to my mind, a far finer eatment of a domical surface than by breakg it up in ribs. Fearing that I might miss y intention to add rather than to diminish eight, the outline of my forms I kept thin, ot more than a quarter or an eighth in idth, and I made use of brown instead of ack. Upon all the interior forms of birds nd trees, I permitted myself neither brown nor black, and kept all the drawing of the wings, feathers, &c., very bright in colour, making use of red, amber, green, blue, grey, both warm and cool, and the high lights of white or a pale lemon yellow. In many instances, notably in the birds which I wanted to appear whitish, I outlined the more delicate parts of their plumage with silver, so that those outlines, when the silver was not shining, might appear to be dark and light off the white when the silver shone. In the leaves of all the trees, I drew the veins with silver, and touched the edges of the leaves with gold. The gold background of the whole design is made of burnt gold and the tesseræ are laid in circles, concentrating at the apex and widening as they descend the curve. Pure white I found to spread excessively, dark blue to tell as black, amber colour to become quite unreasonably dark, pale cool pinks even greyed very much at a distance, and required to be outlined with a strong red to give their value. Both warm and cool greys can be altered as to their appearance very markedly by the colour of the outline by which they are surrounded; outlined with blue, the whole mass by which the outline is surrounded appears to be influenced in a very distinct manner by its environment; so also does the same method hold good when the outline is red. Blue round white intensifies the blue as light, whereas outlined with red, the white appears pink. Strong yellow greens tell extremely well, but they must be outlined with a thick line of red or burnt sienna brown to give them their proper value. White lines in light green are very disastrous except at rare intervals; either a toned grey or a dull yellow breaks the green best. A black outline to blue is only necessary to divide the blue from gold, or to draw the folds of drapery where the lights of the blue are heightened with gold, the black outlining seems to preserve the integrity of the blue, whereas a red outline turns the blue into purple. A dark outline of blue on green gives a very mysterious effect, but, in that case, the blue must be a very clear one, and of a middle tint quality, otherwise the blue will tend to make the green appear muddy.

I have said that I made use of a good deal of silver, notably in the two spandrils and in the dome; I should not use so much silver upon another occasion: it has a great tendency to grey its surroundings. It looks very dark when not illumined. Upon the other hand, when flashing, silver has a greater

power of light and of expansion than gold. A line of silver the sixteenth of an inch in width will eat through the lines of black almost as light eats into the lead lines of a window. The appearance of silver is easily attained without disadvantage by drawing a thin line of white, and outlining it upon either side with a still thinner line of gold. The experiences in working out the dome were most interesting and instructive; the faults I committed were chiefly due to weak outlines, especially upon those parts of the design which have a golden background. The tessaræ which I employed were, on the whole, too small, and from this fact there arose an excess of detail, because I could use a greater number of small tesseræ, and so put in more detail in a given space than I should have been able to accomplish with larger cubes.

The gold background to the design I think I may claim as a success. There is no burnished gold used whatever, the more crackled portions of the burnt cake were invariably chosen, lit here and there with brighter portions cut from same cake; and the gold was mixed, that is to say, red, green, and blue gold were laid side by side. One reason for the brassy and unpleasant appearance of modern golden backgrounds is due to two causes, the first where the tesseræ have been laid too flatly and too closely together; secondly, only one quality of gold, instead of many, has been adopted. Probably, of the two, the more disagreeable effect is obtained by the too close proximity of the tesseræ, but also by the colour of the intonaco upon which they are laid. One need never be afraid of letting the ground show the $\frac{1}{16}$th or even a $\frac{1}{4}$ of an inch in width round each cube. I would even go so far, under certain circumstances of light, to expand even that width. One is far more likely to err upon the thin than the thick joint. Gold set into a white ground never looks so well as when it is set into a red one, the white outline having a tendency to grey the gold excessively; in point of fact, to silver it, it is better to add white curves among the gold, wherever it is desirable to grey the gold.

I have noticed in old mosaics, notably those at the baptistry at Florence, that the ancients recognised the disagreeable appearance of the white line, for they have taken pains to colour the white division with red.* It used to seem to me that the Greek mosaicists employed a St. Mark's, Venice, purposely put spots o black, green, or red among their gold, but have been obliged to give up that idea upo more minute investigation, and to account fo the presence of those black, green, and re spots from the fact that the upper layer of pro tecting glass has corroded where it has bee thinly applied, the gold leaf going with i Thus the colour of the ground upon which has been laid has been revealed. These dar spots, doubtless, have a pleasant effect, but think greater advantage is to be obtained b mixing with the brighter tesseræ those whic have been exposed to heat, and whose dapple surfaces reveal in thin lines all over the su face the colour of their grounds, and so the imbibe both the colour and the brilliancy o the metal. Burnished gold must only be use very moderately; it makes a garish effec except in very thin lines.

In modern Italian restoration of ancien mosaic, bright burnished gold has been set u in the place of dull and broken gold; henc the old work has been rendered vulgar an garish that was only rich and solemn. Th mosaic in the apse of St. Ambrogio, at Milan has been almost spoiled by coarse restoratio in the time of my memory. Red disappear when white gold is used to heighten it in thic lines; it is blackened in the shadow an destroyed in the light; for while the gol shines excessively in full light, and conse quently acts through the edges of every neigh bouring colour, so in shadow does it becom relatively dark, and an extremely powerfu deflector of darks; whereas the modified o crackled gold does not shine so brightly, no does it reflect and refract dark to the sam extent when in shadow. You will probabl remember how thin the spiked gold lines ar which lighten the draperies of most of th earlier mosaics; how, when the gold flashes they only seem to illumine the colour wit which they are mixed, and when they are i shade only give splendour to that local colour That is the right way to use gold. The blac pigment made use of by the old mosaicists Greek and Italian, as far as I have been abl to ascertain, upon close inspection, was of kind of cinder colour, or the grey black o coke, quite dull and unglossy in surface, an excessively corroded by the heat of the kiln They had not a good strong black, so as rule they adopted dark brown as an outlin that told darker than the indifferent black a their command. It must be admitted that th

* You will observe in my diagram on the wall how powerfully white acts upon colour. White cement would grey every tint of even brilliant colour.

·illiant light of the Italian skies does not ɔlige the outlines of forms to be so manifestly sisted upon as in our dark climate; there ırk tells with much greater force than here; here, in Italy, a thin outline of brown would e quite sufficient to detach one colour from nother, and to mark the form, here, to chieve the same result, double the thickness f outline and double its depth in colour is ecessary to achieve the same result.

Messrs. Powell have supplied me with a ɔlendid black, quite invaluable; in shadow it ·lls really black and becomes a deep and leasant grey when the light falls directly pon it; in reflected light it assumes a suffi- iently neutral dark to serve all purposes of a rong outline, so when the work is in full ght the black outlines do not cut too sharply; very unpleasant effect it is when they do, nd in the shade they tell out with full force of ne and accentuate the colour portions which re for the time being in shadow.

I take it that we all learn more by our own iistakes than by what success we may now nd then attain; and I apprehend that you, ıy audience, will gather more good from a etailed account of the growth of my work and f its shortcomings than by a catalogue of my innings. Not unnaturally one was led into ertain mistakes to start with, and these mis- ıkes have gradually taught one right prin- iples — principles not founded upon theory, ıt upon practice and experience.

To revert to the progress of the work, after ıe completion of the small dome, as winter as coming on and the scaffolding was not ɔmpleted, I decided to try two more panels pon slate; these two panels were executed in ıe workshop at Whitefriars. When these ere put in place, I saw the utter futility, once nd for all, of such a practice. My cartoons ad been made previously, and set in place ıey looked strong and light, because of the on-lustrous quality of their surfaces. The osaics, when seen bit by bit, side by side ith the cartoons in the workshop, looked ght, and unmistakeably they are wonderful *ıcsimiles* of my drawings, but the moment I ıw them placed among their surroundings— eep undercutting of mouldings and darkness -it was quite evident that they must be gone ver, and considerably strengthened, not so uch in regard to their local colour as in nphasis of white and black. My dark out- ıes were thin, and my white lines too much ned, and we set at once to work to correct ese defects, inserting outlines of half an inch in width, with the new black among the dark colours; and among the light colours we inserted very pure white drawing lines, or separating lines, especially where a blue and a red of the same tone were in juxtaposition. We also withdrew a great deal of bright gold and inserted dull. The effect was magical, and fully rewarded the labour it obliged—for a labour indeed it was—and you will understand it, when I tell you that so hard had the intonaco become, that a mallet and chisel had to be made use of to remove each single tessera which had been laid into the wet intonaco, now, after the lapse of time of a little over a month, become as hard as flint.

I made up my mind, once and for all, that during winter as well as summer we would work *in situ*, and not any more fumble away at such child's play as executing a decorative work away from its conditions of environment, a practice I believe to be quite fatal to successful decoration, and involving consider- able loss of time and expenditure of energy, because, if the artist is conscientious, he is quite certain to feel himself bound, practically speaking, to re-execute the greater portion of his work, so that it may take its relative place among the objects, of which it should be one, and to which it must bear relation. The practice of painting the decoration in the studio and clapping it upon a wall, differently lighted and differently influenced by the character of architectural mouldings and sur- roundings is a mistake. I defy any artist, even of the greatest experience in decoration, to calculate his effects so minutely in a well- lighted studio so that his work shall appear in its proper relation to the objects which should be at once a part of it when placed in an entirely different lighting, and all the con- ditions of its environment are totally changed; nor do I think that anything but the roughest sketch for colour is desirable for the cartoon. Although every boundary line between shadow and shade, shade and light, should be very clearly defined, because the transposing from one material to another involves changes that can only be made under the eye of the artist himself. It is true that he can calculate roughly for the modifications a necessary part of transposition, but the more delicate modifi- cations, which are the life and soul of success, he can only make when actually working in the material that is ultimately to produce his design; and for this reason it is necessary that the artist should be constantly upon the spot, watching the translation of his design

from one material into another, whenever he cannot himself execute it. If he is not inclined to do this, his work is sure to suffer, for, however clever the workmen may be, not one of them knows really what is the effect the artist has in his mind, and which he desires clearly to render. We know by experience how, in a small way, pictures painted in a well-lighted studio totally change in appearance even when exhibited in a well-lighted gallery from what they were in the studio. And if this be true of an isolated picture, that it receives such a curious impression from its surroundings as to be scarcely recognisable as the same work under different conditions, how much more must the same law apply to a large scheme of decoration.

In the work which has been recently uncovered, I believe that most of the faults which I have confessed to exist in my previous efforts have been overcome. At the same time we are all learning: every day of experience brings new light upon our beautiful art; and while one can never expect to attain perfection, I have no doubt that every fresh adventure will be more successful than the last. The confidence of the public, as well as the kind manner with which our labours have been received by the Press, stimulate us to fresh exertions for the public's instruction and delight.

So have we gone on from space to space, learning and, I hope, improving, until now more than two-thirds of the choir are complete; and if all goes well, I shall have the honour next Easter year to show to the English public a complete scheme of decoration, carried out and fulfilled by English workmen upon a scale second to none in Europe. A new art acquired, a new craft learned, and its difficulties conquered.

And now a word from the ethical point of view.

In a moment of decadence in literature, and in certain forms of art, we are told that art for art's sake is alone to be permitted. Surely that is a very dangerous axiom. In the best times of art, whether in early or recent pagan times, or early or recent Christian times, religion has been glad to accept the services of art to give substance and reality to her mysteries.

The morality of art, the impulses which draw her to choose the noblest events in the history of the world as texts wherein to lay her gold and silver, her colour and her jewels, are aided and strengthened by that consecutive stream of sacred thought upon immortal themes th have exercised man's intellect and feeli even from the prehistoric ages until now.

It is not for us to lay aside such restrair upon our fancies, and such purifying motiv which are induced, by illustrating upon t walls of our churches for the use and servi of all, in a moment when materialism of ma gross kinds is poisoning literature, art, and t drama.

Let us have the best art in our churches th can be obtained, and let the walls of t houses of God be the sacred picture gallerie free for our people, where they can lea nothing but good, by seeing beauty and puri attired; where they can read the old stories the childhood of the world; where they can l refreshed, mind and body, by the study of t beautiful; that beautiful, which, to be perfe must unite the material and the spiritual.

DISCUSSION.

Mr. H. H. STATHAM said that what Mr. Richmo had told them about the experiments he had made the juxtaposition of colours was very interesting. reminded one of music; it was just like the differen in effect that was got by contrasting a sharp ton instrument with a instrument of a mellow tone. was to be found over and over again in orchestr effect. He agreed with Mr. Richmond in his tes mony against bright gold mosaic. Not long sin he saw a fresco executed at the end of a church which the figures were rather dark and the grou bright gold. The result was that what you saw fro the opposite end was a series of irregular brig shapes, and these asserted themselves to the eye the principal things, whereas they were, in fact, t ground. He wished also to express his sympat with what Mr. Richmond said about the decorati of the dome. He had taken the opportunity of sa ing for some years, whenever he could, that it was entire mis-treatment of a dome to decorate it vertical ribs; it was destroying the essential quali of a domical surface. A dome was a kind of unendi surface, and as soon as you began to cut it up in vertical ribs, you destroyed some of its mystery a essential beauty. He hoped they would soon ha the opportunity of coming to the decoration of t main dome in St. Paul's. They were very anxio to see something done about that; and, if he migh he would make a suggestion as to the principle which that should be done. It was a mistake to t to make too much of a storied picture in a dome ve high up like that, where you could never see properly. It was impossible to make out Thornhill pictures properly; they were very dull, and even mosaic it would be difficult to trace out a story

uch a height. What was wanted was something ke, for instance, a glory of angels' wings ascending nd ascending in lessening circles—something that truck the eye as a whole as a grand decorative ffect, but did not require you to follow out the story vith your head bent backwards. He wished to inerpose one note of interrogation on a point which ıad not been touched upon in the paper. The exture which had been aimed at in this mosaic was ery large joints and complex facets of the mosaics o as to reflect the light at different angles. He was nuch taken with that idea when he first heard about t, but he could not help thinking afterwards hat it was a question, and he only put it as a quesion, whether that sort of treatment was not better uited to a Byzantine interior than to a modern Renaissance interior. St. Paul's was distinctly not nly not Byzantine, but the very opposite — a moothed-out refined architecture, and he was not ure whether that roughened texture of the mosaic vas not a little unsuited to that architecture.

Mr. J. T. MICKLETHWAITE said he thought they ought to pass a vote of thanks to the Dean and Chapter for the confidence they had reposed in Mr. Richmond, and for letting him go on in the way he ıad done. The only way to produce a great work vas to let a man do it the best way he could, and let ıim try experiments. Of course if the thing had been done in a purely commercial way, and they were o say, "We have so many square feet of mosaic to cover, what could you do it for per square foot?" it vould not have been possible to correct mistakes. Mr. Richmond was able to do so, and also he earned as he went on. Each year he brought orth something better than the previous year. No doubt what Mr. Richmond had been able to do on so large a scale would show other people how to do t. The decoratlon of St. Paul's was a work so mmensely larger than anything that had been done n modern times, that Mr. Richmond might have been congratulated if he had done only half as well is he had. He had succeeded in creating a new art, ınd produced good work in a method of which he ıad really to learn the alphabet.

Mr. HARRISON TOWNSEND said that there was some difficulty in discussing the paper, because Mr. Richmond had left little for subsequent speakers to say except by way of congratulation. Speaking for some of those who were intimately and specially interested n the art of mosaic, he would specially thank Mr. Richmond for the protest he had raised against the process and the method that was probably more han anything else the cause of the decadence and almost of the death of mosaics in the 16th century. Mr. Richmond's own experimental return to the old process, by which the true and noble works in mosaic were carried out, entitled him to the thanks of every one who loved the art. Those who knew Venice had an object-lesson of the most vivid character in looking at the eastern dome of St. Mark's. The mosaics there were of the 14th century. Not long ago it was possible to see them with those little accidental points of colour and those beauties and subtleties of tone that had been seen in some other and much more modern work. The Italian Government, in their judgment, had the mosaic restored; the whole of it was hacked down from the wall and re-set in a studio at the west-end of St. Mark's. It was re-fixed in the divisions, that he supposed a man did for his day's work, of a metre square, which divisions were now to be clearly seen on the dome, and would exist there for all time as a demonstration of the inferiority of the process—at least, in the minds of all those who could remember the old and beautiful effect of the previous work. He begged to offer his warmest thanks to Mr. Richmond for his highly interesting and instructive paper.

The CHAIRMAN said he felt his own ignorance about artistic matters far too deeply to venture to criticise the very beautiful work that Mr. Richmond had done for them at St. Paul's. It was quite true, as Mr. Richmond had pointed out, that the work had improved from time to time, and it was very important to retain the earlier work to show how the different steps were reached. People sometimes regretted very much, with regard to churches and public buildings, that a great many were built before their right time, but if mistakes had not been made in earlier times, probably we should not have attained to the success we had. The improvements had been learnt by the failures of the past, and he had no doubt in the case of Mr. Richmond, from what he had learned, so he would improve more and more as the work progressed. He was afraid he could not look forward to any early realisation of what Mr. Statham suggested with regard to the dome. There was a great deal to be done yet before they reached the top, and whenever they meddled with Sir James Thornhill's pictures, he imagined there would be a considerable storm around their ears. They had had a certain number of designs, but certainly, although they were done by eminent people, they were very far indeed from being successful. His own impression was that, if they were put up, all London would have cried out against them, and say that it was a great pity to put them in mosaic. He, therefore, thought that it was the best way to go on step by step as they were doing.

The DUKE OF WESTMINSTER, K.G., then proposed a vote of thanks to Mr. Richmond for the admirable paper he had given. Having lately been appointed a member of the decoration committee of St. Paul's, he had the opportunity of seeing the confidence which the Dean and Chapter placed in Mr. Richmond, and also the tenacity with which the latter adhered to his principles, and the way he fought his battle against

and with the Dean and Chapter. No one could have seen the admirable work executed in the chancel without being convinced that the confidence placed in Mr. Richmond was thoroughly well merited. He hoped they might all live for some years to see, if not the completion, at all events great steps made with regard to the further prosecution of this very noble work. Mr. Richmond's attitude with regard to the decoration of St. Paul's reminded him of the saying, "L'audace, l'audace, et toujours l'audace." The boldness of Mr. Richmond was not the least element of his character. If there were any rising architects and decorators present that evening he was sure they might take to heart what had been said, that nothing could be thoroughly well done without the active personal superintendence of the artist or architect.

The vote of thanks having been carried unanimously,

Mr. Richmond said he did not feel disposed to answer one or two little criticisms which had been offered, but one word of Mr. Statham's he might refer to. He had taken objection rather to the rough mosaic; but did any one really like oleographs—an oleograph had a perfectly smooth surface—or did they like the reproduction of a fine Turkey carpet with a smooth surface. The effect of the rough surface of a mosaic acted exactly as the pile of a Turkey carpet acted, or as the granular surface which you always saw in a fine oil painting. Smooth surfaces were always uninteresting, and always uncoloured; but by allowing the surface to receive different phases of light, doubled your chance of colour.

Miscellaneous.

THE WORKING OF BELGIAN VICINAL RAILWAYS.

Ten years ago, a royal decree confided to the Société Nationale des Chemins de Fer Vicinaux the task of endowing Belgium with a series of vicinal or parish railways, perfectly independent of the standard-gauge lines, which latter are more numerous in that country with respect to its area than in many others. The Société Nationale was to receive applications from the communes or individuals interested in making a line, and, when satisfied of its utility, the reasonable chance of its ultimately paying for itself, and the providing of the necessary funds, was to make the preliminary application to the Government for obtaining the concession. In fact, the society was to act as a kind of sponsor for the vicinal lines, having large powers to assist, at the beginning, such that might perhaps never be made without such aid.

The first vicinal line, between Antwerp and Hoogstraeten, was opened on the 15th August, 1885; and so rapid has been the development of th light railways that, at the end of last year, th were no less than sixty-eight vicinal lines co ceded, having a total length of 1,342 kilometres, or 8 miles, although the number of lines is now reduc to sixty-six, owing to fusion in two cases. T importance, already attained and still growing, the vicinal lines, is evidently recognised by t Government, because, by royal decree of the 1: November and 10th December last, all business co nected with them was transferred from the Depa ment of Agriculture, Industry, and Public Works that of Railways, Posts, and Telegraphs, so tl henceforward the relations between the Soci Nationale and the Government will be effect through the Minister of the last-named departme Now that there is an active movement on foot England to promote the making of lines other th those of standard gauge and first-class constructi and equipment, the following particulars as to t results achieved in Belgium during last year's wor ing of her secondary railways will probably posse some interest.

As compared with the length given above, that the end of 1893 was 1237 kilometres, or 769 mile and the additional length of 104 kilometres, or abo 65 miles, is made up by six newly conceded lines, t longest of which—that between Lens, Enghien, a Soignies—is over 30 kilometres, or 20 miles. Of t above lines, 62, or, at any rate, portions of all them, together 1,249 kilometres (776 miles) long, a already opened for traffic; while three others, 6 kilometres, or 43 miles long, are in course of co struction. Of the total length given above, 8 kilometres of line were laid on roads not widened, kilometres on widened roads, and 266 kilometres land acquired for the purpose, the remaining 1 kilometres representing accessory pieces of line, su as crossings and sidings. During 1894, 13 new priva sidings were put in, bringing up the total to 106, which 36 are purely agricultural, for taking off t crops and bringing manure, and 69 industrial, co necting works, quarries, &c.

As regards gauge, the total length is furth divided into 1,056 kilometres of metre-gauge lin 239 kilometres to the Dutch vicinal gauge, and tl remaining 46½ kilometres of standard gauge. should be explained that the metre, or 3 ft. 3⅜ in., the typical gauge that has been adopted for t Belgian vicinal railway, as being sufficiently wide f the traffic of lines not forming part of the regul railway system, and involving small cost for constru tion and equipment. A departure has been ma from this gauge, however, in lines put out towar the Dutch frontier, either to join existing vicin lines, or with the eventual prospect of such junction; and it is only in these cases that th Dutch vicinal gauge of 1·067 metre, or 3 ft. 6 in not differing very greatly from the metre gauge, ha been adopted. Five lines of short length hav also, by way of exception, been made to the standar

uge, in cases where considerable traffic is antici-ted, in order to secure their ultimate absorption the main system. Again, of the 62 lines opened traffic, 60 of them are worked by steam loco-tives, one of short length by horses, and one other that between Brussels and the Petite-Espinette—th electric traction on the Thomson-Houston erhead trolley system.

In addition to the lines already conceded, the vernment has under consideration the expediency conceding 84 additional lines, 1,424 kilometres in gth. Moreover, independently of the vicinal lines nceded to the Société Nationale, there are in lgium six other lines of local interest conceded to parate companies, together 57½ kilometres, or 36 les long which were either conceded before the ciété Nationale began operations, or in whose case at body has waived its first right to a concession. is brings up the actual number of secondary lines seventy-two, having a total length of 1399 kilo-tres (869 miles), which, compared with the length the standard-gauge railways, viz., 4,527 kilo-tres, or 2,813 miles, constitutes a proportion of arly 31 per cent.

Last year, the 61 lines, worked for a net total length 1,159 kilometres (720 miles) and performing a ser-e of 4,615,192 kilometres (2,867,800 miles), earned otal receipt of 5,343,389 francs, and incurred a total pense of 3,770,682 francs, leaving a profit of 572,707 francs (£62,908) which gives a proportion expenses to receipts of 70·57 per cent. Whereas the end of 1893 four lines showed a balance on wrong side, there were only two lines in this sition at the end of last year; and in their case loss has diminished.

The total loss in working since the Société Na-nale was founded, only amounts to 82,114 francs 3,284); and, on the other hand, the general re-ve fund for all the lines attains the sum of 298,757 ncs (£11,950) and the special reserve funds of each e amount together to 199,171 francs (£7,967). dependently of the expenses for working each e, the general administrative expenses of the ciety have been kept down to 175 francs per kilo-tre (£11 5s. 5d. per mile) for the year, these neral expenses, representing 3·78 per cent. of the al expenses incurred for making and equipping the es; and the advance of 1,500,000 francs made by Government to the society was, last year, duced to 1,000,000 francs (£40,000) by the re-yment of 500,000 francs.

Of the total number of lines, 40 showed improved turns last year over those of the previous year's rking; and 36 have yielded a higher dividend than 1893. Among the lines which have been in opera-n at least a year, 18 yield a dividend higher than per cent. and the shareholders will receive a second vidend; 10 others yield a dividend higher than per cent.; and 7 others, one exceeding 2½ per cent. e mean rate of dividend has increased from 2·65 r cent. in 1890, to 2·75 per cent. in 1891, 2·76 per cent. in 1892, and 2·8 per cent. in 1893, to 2·9 per cent last year.

While the total number of kilometres run through increased from 5,157,530 in 1893 to 5,802,131 last year, the number of fatal accidents increased from 25 to 34, and that of injuries to persons from 13 to 15; but nearly all the accidents may be traced to drunken-ness or imprudence.

The society has under consideration the substitu-tion of electrical traction for steam locomotives on several lines; that in the case of the Brussels and Petite-Espinette line having been made on 1st October last, since which time the 15-minutes' service has been perfectly regular. The electro-motive force necessary for working the line is furnished by the Union-Electricitäts-Gesellschaft, of Berlin, working the Thomson-Houston patent, with which a contract has been made for ten years, and which undertakes maintenance, repairs, and renewals, while assuming the whole responsibility. Wherever necessary, the trolley wire and feeders are protected by laths for preventing the contact of tele-graph and telephone wires which might fall upon the line. Lightning conductors are placed on the generating station, on the line, and on the carriages, which latter are fitted with hand-brakes. In the event of accident, however, the current in the motors may be reversed, so as to effect an almost instantaneous stoppage. If, owing to an unfortu-nate coincidence, the hand-brake should happen to give out at the same time as the current, the train may be brought to a standstill, or allowed to descend a falling gradient, at very slow speed, by the two motors being put in parallel. Each carriage is lighted by five 16-candle incandescent lamps, and is warmed by small electric stoves, formed by coils of German silver wire traversed by the electric current. For other lines the engineers are studying a system of continuous warming by steam; but at present slow-combustion stoves, fed by coke or anthracite, that cannot be interfered with by the passengers, have been found to give the best results.

The rates for passengers on most of the lines are 7 centimes per kilometre for first class and 5 centimes for second, or about a penny and ¾d. per mile respectively; and the application of slightly higher rates, viz., 8 centimes and 6 centimes on the Diest and Louvain line, which were stipulated by the Go-vernment in order to prevent too great competition with the existing standard-gauge lines have caused great outcry. Return tickets, with a reduction of 20 per cent. from the double fares, are issued on many of the vicinal lines, but not by any means on all of them; and on a few of the lines the society is authorised to run excursion trains at half rates, and also to grant the same reduction for members of societies travelling in a body. Season tickets at reduced rates are issued in many cases to those attending schools and also to workmen; and on market days cheap tickets are sold, with carriage of goods for sale, accompanying their owner, either free or at very nominal rates.

For the carriage of goods in general there is, in nearly all cases, a fixed charge of 50 centimes (5d.) per consignment, in addition to a rate varying from 3 to 7 centimes per ton per kilometre (corresponding with a maximum of 1d. per ton per mile), these low rates having been made in many cases, during the last two years, with a view to increase the traffic; and they have generally accomplished their desired object.

In the presence of so much success it may perhaps be interesting to give a few particulars of the line which has been least successful. This is one of metre gauge and 22 kilometres (13½ miles) long, between Arlon, the chief town of Belgian Luxemburg and Ethe, in the extreme south of the kingdom, which was opened on 1st August, 1892. The capital is 900,000 francs (£36,000) of which the State subscribed 25 per cent., the Province of Luxemburg 33·3 per cent., and the Communes interested 41·6 per cent., leaving the balance of only 0·1 per cent. subscribed by individuals, an indication of not very sanguine confidence in the success of the line. The total cost of construction, including general expenses, the purchase of land, work and stores, buildings and such works as bridges, and also rolling stock, was 958,886 francs (£38,355), equal to 43,389 francs per kilometre or £2,791, per mile. The expenses of working last year were 40,620 francs, and the receipts only 36,603 francs; but this is an improvement over the corresponding figure of 1893, viz., 30,660 francs. The increase of receipts under the head of passengers is attributed to the facility of communication afforded, and that for goods to the construction and operation of a branch serving some important mills, and extra traffic due to several causes.

The general manager of the society is M. C. de Burlet, Ingénieur-en-Chef, Directeur des Ponts et Chaussées; and the general secretary, M. A. Le Brun, civil engineer. The central administrative staff consists of only 122 persons; and there are 60 executive engineers, surveyors, and inspectors, while 11 agents were employed temporarily last year. There are provident and superannuation funds for all persons employed directly by the Société Nationale, including the hands engaged on the Dolhain-Goé line, which is worked by the society. Nearly all the companies working the other lines have instituted benefit funds for their hands; and the society is exerting its influence to make this arrangement general.

PATENTS IN 1894.

The twelfth report of the Comptroller-General of Patents, dealing with the year 1894, has just been issued. During the year the office received the enormous number of 25,386 applications for patents, and received the large sum of £181,855. Whether more inventions of value are patented than were included in the 5,000 or 6,000 annually registered before the change of the law in 1883, is perhaps a doubtful question. The per-centage of pat[...] sealed has fallen considerably of recent ye[...] Of the 1893 applications, only 47 per cent. bec[...] valid patents. Ten years ago the per-centage was [...] Before the 1883 Act, the per-centage was 65. The [...] centage of patents kept in force by payment of rene[...] fees also shows a steady decline. Only 30 per c[...] survive the first period, and only 6 per cent. las[...] the 14th year. Of the total number of applicati[...] 19,180 come from the United Kingdom, 6,206 f[...] abroad. The United States send the largest num[...] 2,017; then comes Germany, with 1,945; t[...] France, with 799. Of the Colonies, Canada se[...] 141, Victoria 79. The following places have e[...] produced a single invention since 1883:—Bri[...] Honduras, Fiji, St. Helena, Malay Peninsula, W[...] Africa, Madeira, Réuuion, and New Caledonia. [...] number of female inventors is not as large as mi[...] have been expected: 2 per cent., and a fifth of t[...] inventions relate to dress.

The series of classified abridgments of specificati[...] appears hardly up to date, though 17 volumes w[...] issued in 1894; for none of these deal with inventi[...] of a later date than 1883.

During the year 21,230 designs were sent in [...] registration, and 1,025 "sets" of designs. There w[...] 8,013 applications for the registration of trade ma[...]

General Notes.

SHORTHAND WRITERS IN THE ARMY.—[...] Army Order has been issued this month relating [...] the pay of military clerks as shorthand writers. [...] authorises the payment of a certain scale of [...] muneration to military clerks who are in possessi[...] of shorthand certificates from the Society of Arts.

MEETINGS FOR THE ENSUING WEE[K]

MONDAY, JUNE 24...Geographical, University of Lond[...] Burlington-gardens, W., 8½ p.m. Mr. O. [...] Howarth, "The Sierra Madre of Mexico."
British Architects, 9, Conduit-street, W., 8 p.m.

TUESDAY, JUNE 25...Photographic, 12, Hanover-square, [...] 8 p.m. Demonstration of Mr. Packham's proc[...] of Toning Platinum Prints.

WEDNESDAY, JUNE 26...SOCIETY OF ARTS, 4 p.m. Ann[...] General Meeting.
United Service Institution, Whitehall, S.W., 3 p[...] Mr. J. T. Milton, "Water Tube Boilers."
Royal Society of Literature, 20, Hanover-squa[...] W., 8 p.m.
British Astronomical, University College, W. 5 p.m.

FRIDAY, JUNE 28...Physical, Science Schools, South K[...]sington, S.W., 5 p.m. 1. Mr. F. W. Bowd[...] "An Electro-magnetic Effect." 2. Mr. W. [...] Rhodes, "Synchronous Motors." 3. Mr. Shelf[...] Bidwell, "The Electrical Properties of Seleniun[...]

SATURDAY, JUNE 29...Botanic, Inner Circle, Regent's-pa[...] N.W., 3¾ p.m.
Sanitary Institute, 74A, Margaret-street, W.C. [...] p.m. Mr. A. E. Collins, "Scavenging: Dispo[...] of Refuse and Sewage."

Journal of the Society of Arts.

No. 2,223. Vol. XLIII.

FRIDAY, JUNE 28, 1895.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting, for receiving ie report of the Council, and the Treasurers' tatement of Receipts, Payments, and Expen- iture during the past year, and also for the lection of Officers, was held, in accordance ith the Bye-laws, on Wednesday last, the 5th June, at four p.m., Major-General Sir OHN DONNELLY, K.C.B., Chairman of the ouncil, in the chair.

The SECRETARY read the notice convening ie meeting, and the minutes.

The following candidates were proposed, allotted for, and duly elected members of the ociety :—

ddenbrooke, George Leonard, 21, Lichfield-street, Wolverhampton.
shton, James, Norwood Art School, Town-hall, Norwood, South Australia.
olás, Samuel Brittain, 11, Ludgate-hill, E.C.
oot, Horace L. P., 51, Stockwell-park-road, S.W.
road, George F., Windmill-street, Tottenham-court-road, W.
aithness, J. E., 150, Leadenhall-street, E.C.
arter, F. T., 46, Fortis-green-road, East Finchley, N.
larke, S. E. J., Bengal Chamber of Commerce, Calcutta, India.
otterell, Henry F., 58, Woodstock-road, Redland, Bristol.
urzon, Hon. George N., M.P., 5, Carlton-house-terrace, S.W.
oyle, Captain Kinsley Dryden, Royal Small Arms Factory, Enfield Lock.
ifford, J. William, Oaklands, Chard.
aridas, Hardevram Nanabhai, 145, Dulwich-road, Herne-hill, S.E., and National Liberal Club, Whitehall-place, S.W.
ob, Charles, Milton-house, Lindfield, Sussex.
illey, Frederick William, care of Eastern Telegraph Company, 50, Old Broad-street, E.C.
arshall, A. W., The Towers, Pinner, Middlesex.
Moncrieff, Colonel Sir Colin Campbell Scott, K.C.M.G., C.S.I., 11, Cheyne-walk, Chelsea, S.W.
Nâzar, Mansukhlâl Hirâlâl, National Liberal Club, Whitehall-place, S.W.
Preston, Fleet-Surgeon Theodore Julian, 238, Portsdown-road, Maida-vale, W., and Admiralty, S.W.
Pullman, Arthur, Stalheim, Godalming, Surrey.
Rice, Benjamin Lewis, C.I.E., Bangalore, India.
Ross, Arthur, 1, Glengall-road, Old Kent-road, S.E.
Taylor, Henry, Queen's-road, Clevedon.
Thomas, W. Owen, 19, King-street, King's Lynn.
Thompson, George Rudd, 57, Dock-street, Newport, Mon.
Vellacott, Captain John William, Bideford, Bond-street, Albert-park, Melbourne.
Yates, Oswald Vavasour, Wellbank, Sandbach, Cheshire.
Young, Evelyn Henry, Muttra, North-West Provinces, India.

The Chairman nominated Admiral Sir Erasmus Ommaney, C.B , F.R.S , and Mr. John Jewell Vezey, scrutineers, and declared the ballot open.

The SECRETARY then read the following

REPORT OF COUNCIL.

I.—ORDINARY MEETINGS.

The Session opened as usual with an address from the Chairman of Council, Sir John Donnelly, who dwelt on the educational work which has been done by the Society in past years, and pointed out directions in which its educational action might be continued in the future. He suggested that some organisation was required to assist those who are carrying into effect the Technical Instruction Act, and suggested that the Society of Arts might take the initiative in bringing all these bodies together, possibly with the view of their forming some kind of Joint Board. The suggestion thus thrown out has borne fruit in the Conference on Technical Education referred to in another passage of this Report.

At the first meeting after the Chairman's address Mr. Hiram Maxim read the paper on "Aeronautics," which he had promised the Society some time since. Mr. Maxim's experiments in this direction have attracted a great deal of public attention, and, though for many years past, in fact since the invention of the balloon by the Brothers Mongolfier, in 1782, inventors have been working at this problem, Mr. Maxim may certainly be said to be the first who has held out any reasonable probability of a navigable air-vessel ever being constructed.

It had been arranged that at the third meeting of the Session a paper would be read on the "Electrical Treatment of Sewage," by Mons. Hermite. But as this gentleman was unable to fulfil his engagement, a paper on "Fire Protection" by Mr. Sachs was substituted for it. Mr. Sachs suggested a very complete scheme of fire protection for cities, and many of his suggestions are well worthy of consideration.

The next paper was by Mr. Thomas Ward, who gave a very complete account of the "Manufacture of Salt," a manufacture which may be said to be the base of many of our most important chemical industries.

The subject of forestry has been on several occasions of late before the Society, and it is one of the very earliest with which the Society dealt at its origination a century and a half ago. In his paper on it, General Michael brought to bear the long experience he gained in India as one of the principal founders of the Indian Forestry Department, and pointed out how much might be done in this country by a careful application of the knowledge which had now been obtained in India and elsewhere.

At the first meeting after Christmas, Professor Vivian Lewes brought forward a new invention, which is likely to have a far-reaching effect on the gas industry—the method of producing acetylene gas from calcic carbide, a material which he showed could be made in large quantities, and, where water-power is available, at a moderate cost, in the electric furnace, by the synthesis of calcium and carbon. The product is a black stony mass, which, on contact with water, readily evolves gas. The gas thus produced can be used direct as a very powerful luminant, or it may be employed to add to the illuminating power of ordinary gas. The paper attracted a great deal of attention amongst those interested in gas manufacture, as it contained the first account in this country of the new process.

Mr. Stanton's paper on "Tea," the next in order, was principally directed to show how very large a proportion of the tea consumed in Great Britain is now produced in our Indian possessions, the amount supplied by China, from whence, a few years ago, it all came, being a rapidly diminishing quantity.

The following week Mr. Child gave an interesting paper on "Peking," derived from personal experience, he being one of the not very numerous Englishmen who have resided for any length of time in that wonderful city. A special interest was given to this paper by the condition at that time of the war betw[een] China and Japan.

At the next meeting the Duke of Devonsh[ire] presided, when a paper by Mr. Geoffrey Dra[ge] on "The Labour Question in the Colonies [and] Foreign Countries," was read. Mr. Drag[e's] position as Secretary of the Royal Commissio[n on] Labour enabled him to collect a great mas[s of] useful information on this important subject. [He] laid a good deal of stress upon the connect[ion] between socialism and labour organisations [in] foreign countries, and appeared to think t[hat] there was evidence that the doctrines, wh[ich] had certainly led to evil effects in the countr[ies] where they were prevalent, would not be wi[th]out their harmful results here also. The cha[ir]man thought that the general extension of trades' unionism might be looked upon [as] a safeguard against the spread of su[ch] doctrines.

Mr. W. M. Acworth, in his paper on "Lig[ht] Railways," advocated very strongly the co[n]struction of such lines in different parts of t[he] kingdom, and pointed out the advantag[es] which, it is to be hoped, may be realised fr[om] pending legislation on the subject.

The discussion on the "Rule of the Road [at] Sea," which was originated in the autumn [by] the alteration of the rules proposed by t[he] Washington Conference, induced Admi[ral] Colomb to read a paper before the Socie[ty] on this subject, which he has dealt with [in] previous Sessions.

Mr. C. G. W. Lock, who is recognised as [an] authority on the subject of the metallurgy [of] gold, followed with a paper on "Furnaces f[or] Roasting Gold-bearing Ores," in which t[he] most recent devices for effecting that oper[a]tion were described.

At the next meeting, Mr. Radcliffe Cook[e], M.P., gave a practical paper on "Cider," containing much which, it is to be hoped, w[ill] have a useful effect in directing attention to a[n] important domestic industry.

The subject of our food supplies wa[s] dealt with in the two following papers— one by Mr. Montagu Nelson on "Th[e] Meat Supply of the United Kingdom," principally as derived from abroad, and th[e] other by Mr. H. F. Lester on "The Progres[s] of the Abattoir System in England." M[r.] Nelson's paper was an account of the pro[]gress made in developing the importation [of] frozen meat since the time when public atten[]tion was prominently drawn to the subject b[y] the efforts of the Society's Food Committee. Mr. Lester advocated the improvement of th[e]

nethods by which our home supplies of fresh neat are provided.

Mr. Horace Wilmer described the most ecent practical development of photography n his paper on "Modern Photogravure Methods," and gave an admirable practical lemonstration of one of the most general of hese processes.

At the last meeting before the Easter recess, Mr. Holtzapffel, in his paper on "Sand-blast Processes," gave an account of the most recent pplications of this ingenious invention, which vas introduced to the Society by Mr. William Newton twenty years ago. One of these s the production of printing surfaces by a iny jet of sand from a tool which can be uided by the artist's hand, so as to etch way as required the surface of a lithographic tone.

At the first meeting after Easter, one of the atest of all the applications of electricity was escribed by Mr. Crompton, who showed how t could be used effectively and economically or cooking and for heating. Prof. Reinold's aper on the "Deviations of the Compass," ead at the following meeting, described the nethods now adopted in iron ships for obviating the effect upon the magnetic needle of the reat masses of iron of which such ships are omposed. In the next paper, on "The Extraction of the Rarer Metals from their Oxides," Professor Roberts-Austen showed ow the enormous heat obtainable in the electric furnace now enabled the metallurgist to roduce many of the rarer metals, which before had hardly been obtainable except in the nost minute quantities, in masses of considerble size, and in amounts which, in many ases, were capable of practical applications. he most attractive feature of the paper was ne illustration given by Professor Roberts-Austen of the fusing of metallic chromium, an nage of the contents of the crucible being rojected on the screen, so as to be visible to ne audience.

Following this Captain Abney, in his aper on "Means for Mitigating the Fading Pigments," described the very simple, ut most ingenious, method of protecting the contents of picture galleries from ding, which has lately been adopted at outh Kensington. It consists simply in azing the gallery with blue and yellow glass, ranged in such proportion that the mixture the residual lights produces white light. o the eye no difference from ordinary white ght is observable, and, as far as can be ascertained without the actual test of the lapse of time, the device promises to be effective in very greatly diminishing the injurious effect of light upon pigments, nearly all those rays which are known to have a distinctly deleterious effect being stopped out. The method, simple as it is, is the outcome of a long series of scientific experiments. The last paper of the Session was by Mr. Charleton, on "The Dressing and Metallurgical Treatment of Nickel Ores." It was a continuation of the paper which he read last year on "Nickel," and contained an exhaustive account of the metallurgy of nickel. As a permanent record of the present state of this branch of metallurgical science, the paper will be found most valuable.

II.—Indian Section.

The interest taken in this Section has been well maintained, and the meetings have, as usual, received considerable attention in India as well as at home.

The Session opened on December 6 with a valuable paper by a distinguished official of the Government of India, Mr. W. Lee-Warner, C.S.I., on "The Roman and British Indian Systems of Government." Mr. Lee-Warner, whose service in India has extended over a quarter of a century, gave a comprehensive sketch of British administration in our Eastern Empire, suggesting some highly interesting contrasts with Roman methods of provincial government. The Romans, Mr. Lee-Warner pointed out, nowhere met with such a power of passive resistance as our civilisation encounters in India, with its village organisation, with its widespread ignorance, with the hold which its superstitions and faiths exercise on the public mind, and with the confusion of its 81 languages. The Western yeast, he declared, has no doubt begun to work, but the ferment has at present reached only the surface of a corner of society. "The conservative forces of native society are a factor in the present situation, with which Indian officials must deal, and British opinion must recognise their force." Answering the question, "Is British rule popular?" Mr. Lee-Warner observed that, being foreigners and schoolmasters, we can hardly expect to be met with a "wave of gratitude and sympathy," but he had no doubt that the blessings of British peace and British justice are widely appreciated. On January 17 a paper, by a well-known frontier officer, Capt. J. Shakespear, D.S.O., on "The Lushais, and the Land they Live in," was read by

Mr. E. O. Walker, in the unavoidable absence of the author. Capt. Shakespear's admirable contribution was described by the Chairman (Sir Steuart Colvin Bayley) who, as ex-Lieutenant-Governor of Bengal, spoke with authority, as a storehouse of observations interesting and useful to the folk-lorist, the anthropologist, and the administrator. On January 31 a paper by Mr. S. E. J. Clarke, on "India and its Women," was read by Sir Alexander Wilson, who supplemented the author's excellent sketch of household and social life in Bengal, with a brief description of the Countess of Dufferin's Fund "for supplying female medical aid to the women of India." Attention was also called to a cognate organisation, the National Indian Association in aid of social progress and education in India. On February 14, Mr. C. Krishna Menon, Lecturer on Agriculture at the Sydapet College, read an able paper on "Village Communities in Southern India," in the course of which he made several practical suggestions for the reform of rural life in the Madras Presidency on the basis of existing communal institutions. Mr. Menon belongs to the Nair race, and is the first Hindu who has read a paper before the Section. On March 28, Captain F. E. Younghusband, C.I.E., read a paper on "Chitral and the States of the Hindu Kush," giving much valuable information about a region that then was and still is occupying a great amount of public notice. The Hon. George N. Curzon, M.P., presided. On April 25 Mr. J. W. Parry, A.M.Inst.C.E., read an exhaustive paper on "Railway Extension in India," and the Session concluded on May 23 with a very interesting account of the "Customs and Folk-lore of the Northern Balochis," by Mr. Oswald V. Yates, A.M.Inst.C.E. The meetings of December 6, January 31, and February 14, were held at the Imperial Institute.

III.—Foreign and Colonial Section.

The first meeting of this Section was held on January 22nd, when Dr. A. V. Markoff read a paper on "Russian Armenia and the Prospects of British Trade therein." He gave an interesting account of a journey he had made in that country, describing the scenery and the customs of the people, and he suggested various outlets for trade, to which he directed the attention of British merchants. On February 19th, Mr. Alexander F. Baillie read a paper descriptive of the Republic of Paraguay, in which he traced the history of that country from its discovery by de Solis an Cabot to the present day, and described i climate and the efforts which are being mac to increase its trade. Sir Charles Kennec read a paper at the meeting on March 5tl entitled "Colonies and Treaties," in which h explained the relations between the Imperi Government and the self-governing colonies i regard to the making of treaties with foreig countries. In the course of the discussio which followed the reading of the paper, S Charles Tupper pointed out that British colo nies were now admitted to international con ferences on a footing with other nations. O April 2nd, Captain Wiggins gave an interes ing account of his recent voyage to Siberi *viâ* the Kara Sea, and also described th previous expeditions which had been made b himself and others with a view of opening u trade along the Yenisei River. He pointed ou the especial importance of this question, in vie of the making of the Trans-Siberian Railwa Owing to sudden indisposition, Capt. Pasfiel Oliver was unable to prepare a paper on Mada gascar, which he had undertaken to read o April 30th. The concluding meeting of th Session was held on May 21st, when a pape by Professor William Layton, on "Com mercial Education in Belgium," was reac It contained a description of the Commerci University at Antwerp.

IV.—Applied Art Section.

At the first meeting of this Section, on Feb ruary 15th, Mr. Gleeson White read a prac tical paper on "Drawing for Process Repro duction," in which he directed special attentio to the rapid growth of the art of illustratio by means of process reproduction, and th many developments which have come latel into use in the production of books and news papers.

Mrs. May Morris Sparling read a learne paper on "Mediæval Embroidery" at th second meeting, which was illustrated by som fine historical specimens from the South Ken sington Museum, lent by the Science and A Department, and by some lantern slides o fine specimens of embroidery not so generall known, such as the remarkable reredos of th 13th century at Steeple Aston.

At the third meeting, Mr. Alexander Milla read an instructive paper on "Practical Ca pet Designing," which was illustrated b models showing the process of weaving. M Millar, who last year read a paper on "Desig

n Modern Carpets" before the Society, pecially referred in the present paper to the elation between the design and the manuacture, and laid particular stress on the necesity for the understanding by the designer f the possibilities of weaving.

Mr. William Gowland, on April 25th, read n elaborate and most important paper on 'The Art of Casting Bronze in Japan." It ontained a full account of the processes ised by the Japanese from the earliest times. The paper was illustrated by a remarkably fine ollection of ancient and modern bronze bjects by Japanese artists, many of them eing of great value and beauty.

Mr. Thomas Wardle read a paper on May 7th on "The Improvements in the Designing, Colouring, and Manufacture of British Silks since the Egerton Exhibition of 890," which was illustrated by a collection f materials showing the vast improvement n design, colour, and general production of British silks since 1890. The author was able o speak in hopeful terms of the revival of English trade in this manufacture. H.R.H. he Duchess of Teck, President of the Ladies' National Silk Association, honoured the Society y presiding on this occasion.

The Session was brought to a close on May 28th by the reading of a valuable paper on "The Decoration of St. Paul's," by Professor W. B. Richmond, A.R.A., who described the mosaic work in the choir, upon which he is now employed, and the improved methods in its production, which he has revived from ancient Italian practice. The Dean of St. Paul's presided, and the meeting was attended by a large number of architects and others interested in the national work of decorating the Cathedral of St. Paul's.

V.—Cantor Lectures.

Six courses of Cantor lectures were delivered during the Session. The first, of four lectures, was by Professor Vivian Lewes, on "Modern Developments in Explosives." Professor Lewes gave a clear and popular account of the great advances which have been made of late years in explosives, whether used for military purposes, or for blasting. The subject has not previously been dealt with in a Cantor course, and Professor Lewes's treatment of it was much appreciated by an audience which included several of the chief authorities on the subject. The second course was by Professor Silvanus Thompson, on "The Arc Light;" in it he gave an account of the most recent researches into the physics and optics of the arc, as well as a description of the most recent mechanism employed. Mr. Alan S. Cole gave the third course, which was on the "Means for Verifying Ancient Embroideries and Laces." His lectures were fully illustrated by a fine collection of examples, nearly all from South Kensington Museum. The next course was by Dr. Morris, of Kew, on "Commercial Fibres," a subject of the greatest importance to our colonial possessions. When the lectures are published in the *Journal* they will be found to be of even greater value to residents abroad, than to those in this country who are interested in the various industries connected with fibres. Mr. James Douglas, in his lectures on "Recent American Methods and Appliances employed in the Metallurgy of Copper, Lead, Gold, and Silver," gave a great deal of valuable information, and laid stress on the necessity for manufacturers in this country availing themselves of American experience, and adopting those methods which have been found most efficient in America. The sixth and last course of the Session consisted of two lectures by Mr. Ernest Hart upon a subject which he has made his own, that of "Japanese Art Industries." Mr. Hart dealt with his subject from a more commercial point of view than he adopted in his previous lectures on "Japanese Art Work," in 1886. He pointed out that much of the most modern Japanese work is of very high artistic value, and will bear comparison with the productions of the old Japanese masters, and indicated the direction in which he thought Japanese artists should work if they desired to supply the European market. The lectures were finely illustrated from Mr. Hart's own collection.

VI.—Juvenile Lectures.

The Juvenile lectures this year were given by Professor Vernon Boys, the subject being "Waves and Ripples." The lectures were very fully illustrated by experiments, and described to the audience the latest researches of Lord Rayleigh and the lecturer upon this very interesting subject.

VII.—Albert Medal.

The Albert Medal for the present year has been awarded, with the approval of H.R.H. the Prince of Wales, the President of the Society, to Sir Isaac Lowthian Bell, "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his

metallurgical researches and the resulting development of the iron and steel industries."

Sir Lowthian Bell's name has long stood in the first rank of British metallurgists. His researches into the chemistry of the blast-furnace have not only a high scientific value, but they have had a wide practical application in increasing the output of the metal, and have consequently had a very great influence upon one of the most important of British industries.

VIII.—Medals for Papers.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1893-94.

At the Ordinary Meetings:—

To Hiram S. Maxim, for his paper on "Experiments in Aeronautics."

To Thomas Ward, for his paper on "The Manufacture of Salt."

To General J. Michael, C.S.I., for his paper on "Forestry."

To Prof. Vivian B. Lewes, for his paper on "The Commercial Synthesis of Hydrocarbons."

To A. G. Stanton, for his paper on "Tea."

To W. M. Acworth, for his paper on "Light Railways."

To J. J. Holtzappfel, for his paper on "Sand-blast Processes."

To A. G. Charleton, for his paper on "The Dressing and Metallurgical Treatment of Nickel Ores."

In the Indian Section:—

To the Hon. W. Lee-Warner, C.S.I., for his paper on "Roman and British-Indian Systems of Government."

To Capt. John Shakespear, D.S.O., for his paper on "The Lushais, and the Land they live in."

To C. Krishna Menon, for his paper on "Village Communities in Southern India."

In the Foreign and Colonial Section:—

To Dr. A. Markoff, for his paper on "Russian Armenia and the Prospects for British Trade therein."

To Capt. Wiggins, for his paper on "My Recent Voyages in Siberia."

In the Applied Art Section:—

To Mrs. May Morris Sparling, for her paper on "Mediæval Embroidery."

To William Gowland, for his paper on "The Art of Casting Bronze in Japan."

To Prof. W. B. Richmond, A.R.A., for his paper on "The Decoration of St. Paul's."

The thanks of the Council were also voted to the following members of the Council:—

To Capt. W. de W. Abney, C.B., F.R.S., fo[r] his paper on "Means for Mitigating the Fading o[f] Pigments."

To Sir Charles M. Kennedy, K.C.M.G., C.B., for his paper on "Colonies and Treaties."

To Prof. W. Chandler Roberts-Austen, C.B., F.R.S., for his paper on "The Extraction o[f] the Rarer Metals from their Oxides."

IX.—Owen Jones Prizes.

This competition was instituted in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon condition of their expending the interest thereof in prizes to "Students of the Schools of Art who, in actual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were awarded this Session, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The list of the successful candidates was given in the *Journal*.*

The next award will be made this summer, on the result of the present year's examinations. Six prizes have again been offered for competition.

X.—Silver Cup for Swiney Prize.

It was announced in last year's Report that the Council of the Society had offered to award a prize of £25 for the best design for a silver cup of the value of £100, the object being to obtain a more suitable design for the Swiney Cup than the original design by Maclise. The offer was open to all students of schools of art in the United Kingdom. Designs were sent in, and were adjudicated on by a special committee, which reported that none of the designs was worthy of the prize offered, but recommended that the amount should be divided among the three competitors whose work showed the greatest merit. The names of these have appeared in the *Journal*.†

XI.—Prizes for Photogravure.

In February last the Council determined to offer the following prizes for the best Photogravure plates and negatives:—

* See *Journal*, Sept. 14, 1894. † See *Journal*, March 1, 1895.

(1) A Prize of Twenty Pounds (with a Silver Medal) or a Gold Medal for the best reproduction of a selected picture by a Photogravure process.

(2) A Prize of Ten Pounds and a Silver Medal for the best Photographic Negative of a selected picture, suitable for reproduction by a Photogravure process.

Competitors were required to send in, by the 31st April, a reproduction of Mulready's picture, "Choosing the Wedding Gown," now in the South Kensington Museum, this picture having been selected on account of the difficulties it presents to reproduction by purely photographic and mechanical means. It contains a great variety of colours with strong contrasts, and many of the tints are precisely those of which it is more difficult to render the values in light and shade by photography.

There were in all 19 competitors. The results of the competition will be found in the Report of the Committee, published in the *Journal* of June 7th, 1895.

The Council consider that the Society is greatly indebted to the Science and Art Department, which granted facilities for the copying of the picture, and also to the officials of the Department upon whom, in carrying out the necessary arrangements, a good deal of trouble was thrown.

The works sent in were exhibited for a short time in the Society's house.

XII.—Prizes for Drawing.

Since 1889, the Council have placed at the disposal of the Royal Drawing Society, for competition among the candidates at its annual examination, 12 Bronze Medals, and, as usual, these medals were awarded for drawings sent in by students to the exhibition held by the Drawing Society in April last. This offer of the medals has been renewed for next year.

XIII.—Examinations.

The rapid increase which has been shown of late years in the numbers of candidates entering for the Society's Examinations is still noticeable. The rate of increase is about the same as in the past two years: 4,777 candidates worked 5,108 papers this year; last year 4,106 worked 4,375. There is, therefore, an increase of 733 in the number of papers worked.

The Examinations of the Society were established in 1856, and up till the year 1880 they were free. During that period the greatest number examined in one year was in 1869, when 2,160 candidates worked 3,193 papers. In that year there was a choice of 36 subjects, most of which were afterwards abandoned, as they were taken up by other organisations. In 1880 it was proposed to drop all the Examinations in commercial subjects, the Council at that time being under the impression that the need for such Examinations was adequately supplied by other institutions. Upon the remonstrance, however, of certain provincial institutions, this decision was reconsidered, and in 1882 the Examinations were re-established on a fresh basis, a fee of 2s. 6d. being charged for each subject. In 1882 only 695 papers were worked. In the following year there were 845, and this number increased slowly to 1,531 in 1888. The increase then became more rapid. In 1890 there were 2,474; last year, 4,375; and the large number above mentioned—5,108—has been reached in the present year. This very considerable increase is doubtless, to a very large extent, due to the cause to which it was attributed in the report of last year, namely, the fact that the County Councils have now large funds available for the promotion of technical education; and that certain commercial subjects are scheduled by the Science and Art Department as subjects coming within the scope of the Technical Instruction Act, 1889. The commercial subjects so scheduled are precisely those in which the Society of Arts has now for just forty years been holding Examinations. The manner in which the Examinations of the Society have been taken up by those who are anxious to encourage instruction in commercial subjects is a gratifying testimony to the value of the Society's work, and not only have the number of candidates so largely increased, but the number of centres at which Examinations are held has also shown a steady and satisfactory increase. There were 78 in 1891, 96 in 1892, 109 in 1893, 131 in 1894, and 146 in 1895.

In comparing the results of the present year's Examinations with those of last year it is a little remarkable to notice that the per centage of first-class certificates has risen from 11 per cent. in 1894 to 14 per cent. in 1895; and that of candidates who have not passed from 17 per cent. to 21 per cent.; while the per-centage of candidates who took second and third-class certificates has fallen. The per-centage of second-class was 33 in 1894,

and 28 in 1895. The per-centage of third-class was 36 in 1894, and 32 in 1895.*

The increase is practically spread over all the 14 subjects in which Examinations were held, as in only one subject, that of English, has there been even a nominal decrease, 177, as compared with 178. It may be noted that this and Arithmetic are the only two subjects which are not included among the subjects for which minutes have been passed by the Science and Art Department under the Technical Instruction Act. In Portuguese the same number of candidates were examined this and last year.

The most popular subject is still, as in former years—that of Book-keeping, 2,348 papers having been worked in this subject, an increase of 222 over last year. The examiner speaks highly of the standard reached by the papers. He says:—"The accuracy and finish of the papers is unexampled during the past twelve years." He has, therefore, been able to award a very high per-centage of first-class certificates—20·7—whereas last year the proportion was only 8·37, and the average of ten years previous 12·36. Only 7·36 per cent. were not passed; last year the per-centage was 10·02, the ten-year average is 8·6.

The next largest number was in Shorthand. There were 1,030, an increase of 225 on last year. The examiner, however, does not report a corresponding improvement in the character of the papers, which he says do not compare favourably with those of last year; whereas last year exhibited a marked improvement on the work of preceding years. In spite of the increase in the number of papers worked there has been a decrease in the total number obtaining first-class certificates, and the failures are more numerous.

Satisfactory evidence of the value of these examinations is afforded by the recent issue of an army order, relating to the pay of military clerks employed as shorthand writers, and authorising the payment of a certain scale of remuneration to military clerks who are in possession of shorthand certificates from the Society of Arts.

None of the other commercial subjects show such large numbers as the above. The next in order are French, 244; Type-writing, 242; English, 177; German, 152; Arithmetic, 139; and Spanish, 124.

It is satisfactory to note the increase in Arithmetic, which of late years has be rather a declining subject. The number h risen from 81 in 1894, to 139 in 1895, a numb which still shows the miserably inadequa amount of attention paid to this importa subject. The examiner reports that t number of conspicuous successes were abo the same, and the per-centage of failures w about the same, so that the increased numbe contributed a large accession to the thir class. It is to be hoped that these candidat will pursue their studies further, so that th may in a future year obtain a first or secon class certificate. Special attention should b paid to the very valuable suggestions whic Professor Hudson always appends to the an swers to his questions, published wfth th questions themselves.

The examiner in English reports tha although the general average and intelligenc of those who have passed is quite as high a usual, there are this year exceptionally fe who are entitled to the distinction of firs class. He remarks that this year many stu dents have been induced to come up who di not possess even the most elementary know ledge of the subject, and whose papers ar absolutely worthless. As some of these paper come in groups together, it is evident that the are sent from the same centres. Teacher should bear in mind that while it is mos desirable to encourage their students to ente for Examinations as soon as they are qualifie to do so, it is worse than useless, since it i discouraging to the students, to send them i before they have attained a proper degree o preparation.

The numbers in Commercial Geography wil perhaps, never be very high, but it is at a events satisfactory to see that as many as 5 candidates now enter for a subject, for whic but very few years ago there were none at al Having in view the importance, and also th interesting character of the subject, it is to b regretted that more students do not appl themselves to it. The general level of th work was very satisfactory, only two of th candidates who were sent up failing to pass and seven were placed in the first-class. Th examiner remarks that comparing the result with a few years ago the present year give evidence of real progress, and the answer make it clear that great care has been take in preparation. As a rule the information o the candidate was up to date, and the error committed were of a class different from thos formerly common.

* These per-centages, it should be noted, are only approximate.

Type-writing is a popular subject, 242 candidates entering for it; but it is evident that this number is obtained rather at the expense of quality. It is apparent that many candidates enter themselves who are quite unfitted for the work, and who are lacking in the general education and intelligence required for a high class type-writer. The examiner suggests that a pass examination in spelling and English should be insisted upon by teachers of type-writing before pupils are admitted to their schools. At all events, it may be urged upon teachers that they should not encourage candidates to enter for these Examinations whose only qualification is a knowledge of how to manipulate the keys of their instrument. After eliminating these candidates, who, indeed, should never have entered, the remainder may be spoken of in terms of commendation. The first-class papers are exeedingly good, and the second-class also show considerable merit. Many candidates who took second-class certificates sensibly confined their efforts to doing the easier portion of the paper correctly, thus securing full marks for the parts which they did.

The examiner in French expresses himself as well satisfied with the work, which, he considers, shows an improvement on most previous Examinations. The general average is good. There are few absolutely bad, but the proportion of decidedly good papers is not very large.

The examiner in German considers the result of this year's examination highly satisfactory, both as regards the number of candidates and the quality of their work. The number, Dr. Buchheim states, is the largest he has ever had to examine for the Society.

The examiner in Italian finds the work very much of the same level as last year—neither better nor worse. Some of the translations from and into Italian were very well done, and the technical part of the paper was satisfactorily dealt with by most of the candidates. The number of papers worked was only 25.

The numbers in Spanish show a satisfactory growth—124, or 18 more than last year. The numbers in this subject have shown a steady increase of late years, and have now reached a number more than double that of a few years ago. The examiner reports the results as satisfactory, the per-centage of failures being low, and the commercial part somewhat better done than last year.

In Portuguese, as mentioned above, there has been no increase in the small number of 13, nor can the examiner find very much difference in the character of the work sent in.

The number of candidates in Domestic Economy does not show a great increase over last year, 133 against 128. The examiner, however, expresses the opinion that there is a marked improvement in the working of the papers, which are better than those of any previous year.

In both of the two subjects into which Music is now divided—rudiments of music and harmony—there is an increase, 290, as compared with 238 last year, and 139, as compared with 102. The general standard, however, of the papers worked in these Examinations appears to be slightly lower than last year, and the best of the first-class are certainly inferior to the best papers worked last year. Sir Joseph Barnby having felt obliged to resign his examinership in consequence of the pressure of other duties, the Examination this year was carried out by Mr. McNaught alone.

The Council have to acknowledge the assistance which has been given to the Society by certain of the City companies, who have conbuted to the prize funds. There can be but little doubt that the prizes thus provided have a considerable effect in attracting a higher class of candidates.

The following are the companies contributing:—Clothworkers, Goldsmiths, Merchant Taylors, Skinners, and Salters.

XIV.—Practical Musical Examinations.

As above mentioned, pressure of work at the Guildhall School of Music compelled Sir Joseph Barnby to resign the duties which he had discharged with much satisfaction to the Council as Examiner in Music in conjunction with Mr. W. G. McNaught. In consequence, the Council invited Mr. John Farmer, of Balliol College, Oxford, to undertake the superintendence of the practical examinations, and at Mr. Farmer's request, Mr. Ernest Walker was associated with him as Assistant Examiner.

The examinations for this year commenced on the 17th of June, but as they are not yet concluded, it is not possible to give their results in this Report; 395 candidates entered for the examination. A summary of the results will be published in the *Journal* as soon as it can be prepared.

XV.—Conference on Technical Education.

The suggestion made by the Chairman of

Council in his opening address, as to the need for further organisation in matters connected with technical education, led to the holding of a Conference on the subject on the 20th of June.

This Conference was largely attended by representatives of the Technical Committees of the various County Councils and others interested in technical education. Sir John Donnelly presided, and in his opening remarks he submitted to the Conference, as the principal points for their consideration, the necessity for the development of existing examination systems, so as to provide for examination and inspection in those subjects for which minutes had been granted by the Science and Art Department under the Technical Instruction Act, 1889; and the desirability of having some central office, from which assistance and information might be obtained by local authorities with regard to examinations and inspections in those subjects.

After considerable discussion, the general feeling of the Conference appeared to be that there was need for further inquiry before any definite action could be taken, and the following Resolution, proposed by Mr. J. H. Reynolds, of Manchester, and seconded by Mr. C. Courtenay Hodgson, of Carlisle, was carried :—

> "That, in the opinion of this meeting, it is desirable that provision should be made for examination and inspection in the subjects of instruction undertaken by Technical Instruction Committees, but not at present included in the schemes of the Science and Art Department, the City and Guilds of London Institute, and the Society of Arts, and that, with the object of giving effect to the same, this Conference recommends that a representative committee be appointed to draw up a report and prepare recommendations on the whole subject."

The Council have not as yet had an opportunity of coming to any decision on this question, but it wtll shortly receive their most careful consideration.

XVI.—Conversazione.

The annual Conversazione of the Society was held, by permission of the Lords of the Committee of Council on Education, at the South Kensington Museum, on the 19th June. The Common Council of the City of London had very kindly granted permission for the holding of the Conversazione this year at the Guildhall, but on inquiry it appeared that the cost of adapting the Guildhall to such a purpos would amount to more than the Society ca properly expend on an entertainment, and th Council were, therefore, with much regre obliged to abandon the idea, though they ha no doubt that the novelty of holding it at th Guildhall would have made the Conversazion specially attractive to many of the member

The numbers attending at South Kensington were 2,208. On this, as on many previou previous occasions, the Council have to expres their appreciation of the assistance which wa rendered to them by the principal officials an the staff of the Museum.

XVII.—Society's Meeting-room.

In consequence of the rebuilding of th premises of the Institution of Civil Engineers several of the societies who were in the habi of meeting there applied to the Society of Art for permission to meet in the Society's house and there has, consequently, been a more tha usual demand for the use of the meeting-room Among the societies who were thus accommodated were the Institution of Electrical Engineers, the Iron and Steel Institute, and th Federated Institution of Mining Engineers The following institutions have been for som time in the habit of meeting regularly in thi building, Naval Architects, Central Chambe of Agriculture, Bath and West of Englan Agricultural Society, and the Board o Governors of Dulwich College. Meeting have also been held by the Charity Organisation Society, the Society of Women Journalists, the Press Fund, the Royal National Lifeboat Institution, the Camera Club, the Ar Union, and various others.

XVIII.—New Council.

The Vice-Presidents whose terms of offic expire at the end of the Session are:— Sir Frederick Abel, Sir George Birdwood, Sir Frederick Bramwell, Sir Henry Doulton, and Mr. J. Biddulph Martin. To fill thei places the Council propose Sir Edwar Birkbeck, Mr. B. Francis Cobb, the Hon. Sir Charles W. Fremantle, Sir Douglas Galton, and Prof. W. C. Roberts-Austen. Si Charles Fremantle, the late Deputy-Master o the Mint, has never previously served on the Council; Sir Edward Birkbeck and Sir Douglas Galton have held office in former years, the latter having been for two years chairman; Mr. Cobb was one of the treasurers last year, and Prof. Roberts-Austen one of the ordinary members of Council.

The retiring members of Council are Mr. alter H. Harris, Mr. John O'Connor, Mr. orence O'Driscoll, and Prof. Roberts-Austen. ie Council have nominated, to fill the cancies thus caused, Sir Steuart Colvin iyley, Major-Gen. Sir Owen Tudor Burne, r. R. Brudenell Carter, and Prof. Francis gar. All these gentlemen, except Sir Steuart iyley, have had previous experience of the ›rk of the Council.

As treasurer, the Council propose Sir ederick Bramwell, in place of Mr. Cobb, io retires from the office of Treasurer.

XIX.—Chicago Exhibition.

It was stated in the last Report of the ›uncil that the business of the Chicago Comittee was practically concluded, and its port issued. As, however, there were at that ne certain outstanding accounts, the Comission were not able to wind up its affairs for me months later. Its final meeting was held the 26th of November, 1894; and the conıding financial statement, supplementary to e statement issued with the Report, was blished in the Society of Arts *Journal* of e 14th of December, 1894. Inasmuch as e medals and diplomas awarded to the exbitors have not yet been issued, the work of stributing those for the British exhibitors ll remains to be done on behalf of the Comission. It cannot be denied that the value the awards has been much diminished by e long delay in issuing them to the recipients. has not even been possible to procure for hibitors a representation of the design of the edal. This question of the medals, and rtain questions relating to the still outstandg claims of certain exhibitors for damage ne to their goods in the fire which occurred the Exhibition building in January, 1894, ve involved a good deal of correspondence iich still continues.

XX.—Journal Indexes.

The indexes for the 10 years' volumes of the *urnal*—Vols. 31 to 40—have now been ialgamated, and issued as the fourth 10-›lume Index to the Society's *Journal*. ie three 10-volume indexes for the first 30 lumes of the *Journal* are all in print, and n be supplied to any members who require em.

XXI.—Obituary.

Amongst those members whose loss during e past year the Society has to deplore, were many who have been long associated with the Society, and have taken an active share in its work. Prominent among these may be mentioned Mr. Hyde Clarke and Mr. Thomas Twining. Both of these gentlemen served for many years on the Council, and attended its meetings regularly. To Mr. Hyde Clarke was due the origination, first, of the Indian Section, and, afterwards, of the African Section, which later on became the Foreign and Colonial Section. Mr. Twining was one of the first to draw attention to the necessity for improved means of Technical Education, and he continued his efforts in this direction down to his death. Lord Aberdare was for some time a Vice-President of the Society, and on many occasions took an active share in its work. Sir Edward Inglefield also served on the Council. Sir Robert Hamilton took a great interest in the examination work of the Society, and for sixteen years acted as examiner in Book-keeping. Mr. W. Topley and Dr. Alder Wright contributed valuable papers and lectures to the Society. Mr. William Botly was for many years one of the most regular attendants at the Society's meetings, and took a frequent part in the discussions. Although in the later years of his life Mr. John Bell's connection with the Society of Arts ceased, he was a member of the Council as far back as 1849, and contributed several papers to the meetings. Amongst other members of note who have died during the past year should also be mentioned Lord Selborne; Mr. John Walter, of the *Times*; Sir Daniel Lange; Mr. A. E. Durham, the eminent surgeon; and Mr. Wyatt Papworth, the well-known writer on architectural subjects. Biographical notices of these, and of other members, have already appeared in the columns of the Society's *Journal*.

XXII.—Finance.

The annual statement of receipts and expenditure was published—in accordance with the usual practice—in the *Journal* last week. After mature consideration, the Council decided to take advantage of the high price of Consols, and to sell out £10,000 of the Society's funds invested therein. Of this amount, they re-invested £9,979 4s. in the purchase of freehold ground-rents at Battersea-park, which they purchased from Her Majesty's Office of Works and Public Buildings. The balance, £464 10s., has been carried to capital account, and will (after the payment of cost of conveyance)

be duly invested. The investment will produce a settled and secure income of £369 12s. It will also, of necessity, appreciate in value as time goes on, and the reversion on expiry of the leases under which the property is now held draws nearer.

The CHAIRMAN moved the adoption of the report, and Sir OWEN ROBERTS seconded the motion.

Mr. COBB congratulated the Society on the satisfactory condition of the finances, more especially in respect to the profitable transfer of £10,000 from consols to freehold ground rents, which would increase in value in due course.

Mr. T. HILTON remarked that country members, who were unable to attend the meetings, would see, from the report which the Secretary had read, that the work of the Society was fully up to the standard of its earliest and most vigorous days. With regard to that part of the report which dealt with the recent Technical Education Congress, he pointed out that candidates could not be expected to come up in large numbers from the country for examination. The Hampshire County Council, of which he was a member, had included railway carriage building as one of their technical subjects for instruction. Members would understand how this came about, when he mentioned the fact that the London and South Western Railway had large works at Eastleigh. The Hampshire County Council had also recently started a farriery school; and a fully equipped waggon would be sent round to the different villages, so that instruction might be given in the shoeing of horses, and general smiths' work. As a rule, he thought the instruction imparted under the Technical Education Committees was of a superficial character; he had hoped that it would have taken a higher grade leading up to apprenticeship.

The CHAIRMAN said that if the Society enlarged its existing system of examinations, their examinations would still take place at the local centres, and candidates would not have to come up to London to be examined. As for the teaching being superficial, it was to be remembered that, under the terms of the Act, instruction in trades or professions could not be given.

Mr. R. MANUEL referred to the expiry of the lease of the house, and asked what action was being taken by the Council.

The CHAIRMAN said the Council had had the question of the lease before them for some years past, and had appointed a Committee to deal with it. They were quite aware of the necessity for action in the matter.

Mr. A. BARCLAY asked whether anything had been done towards the compilation of a sketch o history of the Society alluded to by the Chairm his late address.

The CHAIRMAN said that several accounts of Society were in existence. Nothing fresh had done at present in the matter.

Mr. MARTIN WOOD thought that these meet were valuable as affording the members an op tunity of expressing their opinion on the work of Society, and certainly, for the work of the pre session only praise could be given. He was sc however, that the annual meetings were not held ir evening, when a larger attendance might be expec He also alluded to the loss of Mr. Hyde Clarke, was a constant attendant at these meetings.

The adoption of the report having been carried

The CHAIRMAN moved a vote of thanks to officers of the Society, which was seconded by OWEN ROBERTS, and carried unanimously,

The SECRETARY returned thanks to the Soc for this expression of confidence in himself, an the other officers of the Society.

The ballot having remained open for hour, and the Scrutineers having reported, CHAIRMAN declared that the following been elected to fill the several offices. names in *italics* are those of members have not, during the past year, filled the of to which they have been elected.

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Saxe-Coburg and Gotha, K.G.
H.R.H. the Duke of York, K.G.
Duke of Abercorn, K.G., C.B.
W. Anderson, D.C.L., F.R.S.
Sir Edward Birkbeck, Bart.
Sir Courtenay Boyle, K.C.B.
Michael Carteighe.
B. Francis Cobb.
Major-General Sir John Donnelly, K.C.B.
Hon. Sir Charles W. Fremantle, K.C.B.
Sir Douglas Galton, K.C.B., D.C.L., F.R.S.
Lord Halsbury.
Lord Kelvin, P.R.S.
Sir Charles Malc Kennedy, K.C.M C.B.
Sir Stuart Knill, B Alderman.
Sir Frederic Leigh Bart., P.R.A.
Sir Villiers Li K.C.M.G.
William Henry Pre C.B., F.R.S.
Prof. William Chan Roberts-Austen, C F.R.S.
Sir Albert Kaye Rc M.P., LL.D.
Earl of Rosebery, K.
Sir Saul Sam K.C.M.G., Q.C., M
Sir Richard Web G.C.M.G., Q.C., M

ORDINARY MEMBERS OF COUNCIL.

aptain W. de W. Abney, C.B., F.R.S.	*R. Brudenell Carter, F.R.C.S.*
ir Steuart Colvin Bayley, K.C.S.I., C.I.E.	Sir George Hayter Chubb.
ohn Wolfe Barry, C.B., F.R.S.	*Francis Elgar, LL.D.*
ord Belhaven & Stenton.	Prof. Clement Le Neve Foster, D.Sc., F.R.S.
eorge Ledgard Bristow	Sir Westby B. Perceval, K.C.M.G.
lajor-General Sir Owen Tudor Burne, K.C.S.I., C.I.E.	Alexander Siemens.

TREASURERS.

ir Frederick Bramwell, Bart., D.C.L., F.R.S.	Sir Owen Roberts, M.A., D.C.L., F.S.A.

SECRETARY.

Sir Henry Trueman Wood, M.A.

On the motion of the CHAIRMAN, seconded by ORD BELHAVEN AND STENTON, a vote of thanks as passed to the Scrutineers, which was carried nanimously.

Sir STUART KNILL, Bart., proposed a cordial ote of thanks to the Chairman for his valuable ervices as Chairman of the Council, which, he was ure, they all appreciated.

The resolution was seconded by Sir CHARLES KENNEDY, K.C.M.G , and carried.

The CHAIRMAN acknowledged the vote of thanks, nd the meeting then adjourned.

Miscellaneous.

THE TEXTILE INDUSTRIES OF GERMANY.

The woollen industry in Germany has been highly eveloped for some centuries. Its principal production was originally cloth, for which the home-rown wool formed an excellent material. The voollen manufacture of Rhenish Prussia, which holds he chief position, had already contained considerable mportance in the 12th century, and even then exported its products. A little later, this industry xtended to Brandenburg, Saxony, and Lusatia, and eached there, also, in a high state of perfection. According to a recent German trade review, among he woollen productions of the country, are particularly to be mentioned cloth, buckskins, and material or men's suits and overcoats, as well as for ladies' nantles in all the various kinds and qualities lemanded by fashion. The principal centres of the industry are the towns of Aix-la-Chapelle, Düren, Eupen, Lennep, &c., in Rhenish Prussia, as well as the provinces of Brandenburg, Silesia, Saxony, Lusatia, with numerous places, excelling in their own particular productions, among which are to be mentioned Berlin, Cottbus, Spremberg, Schweibus, Forst, Sagan, Sprottau, Sommerfeld, &c. In addition, the manufacture of dress material, partly of pure wool, partly of wool unmixed with cotton, is of great importance. The centres of this industry are Saxony, Silesia, Rhenish Prussia, and Alsatia. Gera and Greiz have not only preserved their old renown in the production of merinos and cashmere, but manufacture combed wool materials, in excellent qualities, for ladies' and gentlemen's garments, which are exported to all parts of the world. For coloured woollen dress goods, Alsace, with a highly developed industry, which occupies a leading position, is deserving of mention. For materials for furniture, Chemnitz and Elberfeld are renowned. The manufacture of plush is carried on in Rhenish Prussia and Westphalia, Elberfeld, Viersen, Mulheim-on-the-Rhine, and Bielefeld. The shawl industry has its principal seat in Berlin and the Bavarian Voigland. The carpet industry boasts of a high development, and produces Brussels, velvet pile tapestry, and Axminster qualities. Of considerable importance is the manufacture of Oriental carpets in knotted work, which are made in excellent qualities and patterns, and are largely exported. The number of spindles in use for combed wool is estimated at 1,600,000, and for carded wool at 200,000. The German cotton industry is highly developed. Germany possesses about 3,500,000 spindles. Plain cotton tissues, such as calico shirtings, &c., are principally manufactured in Bavaria, Alsace, and Silesia. For cotton velvets and velveteens, Linden, near Hanover, Eltlingen (Baden), and Berlin are renowned, these places producing articles that may be classed among the finest of the Continent. The weaving of the coloured goods, which includes articles for men's and women's clothing, is most flourishing. Alsace, Rhenish Prussia, and Westphalia, as well as numerous districts in Bavaria, Wurtemburg, Saxony, and Silesia, are important centres of this industry. The manufacture of nansook, muslin, flannelettes, piqués, sateen, coloured stuffs for table-cloths, bed covers, dressers, &c., is very important. In Alsace, Silesia, and Bavaria bleaching and dressing are important industries. Printing is one of the most important branches of the German collar trade. The linen industry is of great antiquity. Favoured by an extensive cultivation of flax, it not only supplies the wants of the country, but exports large quantities of thread and linen to other countries. In spinning, the spinning-jenny has almost entirely supplanted the spinning-wheel, and the mechanical loom is coming more and more into use, although the hand loom still forms an important factor in this branch. The principal districts of the linen production are Silesia, Westphalia, Saxony, Bavaria, and Wurtem-

burg. Silesia has numerous branches of the linen industry, which are carried on both by machine and hand-looms. The manufactures of Bielefeld are of great repute. The manufacture of underlinen is carried on extensively, more especially in Berlin and Bielefeld. It produces ready-made shirts, collars, and cuffs, and exports largely. The jute trade has greatly prospered during the last ten years, and has in use about 76,700 ordinary spindles, 2,000 thread spindles, and 3,600 machine-looms. The German silk trade has its centre in Rhenish Prussia, particularly in the district of Crefeld, and its productions are well known in all parts of the globe. The most varied fabrics are produced, black and coloured materials of the heaviest qualities for dresses, as well as the thinnest for linings; fancy trimmings, in pure and mixed silks; sateens, materials for umbrellas, cravats, and clerical vestments, plush black and coloured piece velvets and ribbons. In most of its products, Crefeld holds the first position. Of late the machine-loom has been used more and more in this trade. Besides Crefeld, the silk and velvet trades are established in Elberfeld, Viersen, Gladbach, Müllheim-on-Rhine, Bielefeld, as well as in Freiburg, in Baden, and in Upper Alsace. Hosiery is of great importance in Germany, and large quantities are exported. The chief places for this trade are Saxony, with Chemnitz as the centre of a great trade, as well as Middle Franconia, in Bavaria, and the district of the Black Forest in Wurtemburg. The manufacture is carried on in large separate establishments, which are equipped with the latest machinery. The trimming industry is brought to a great perfection, and excels as well in staple goods as in novelties. Barmen enjoys a great reputation for its ribbons, cords, laces, galoons, and other articles, whilst trimming for ladies' dresses, &c., are made in accordance with the changes of fashion in Berlin, Annaberg, Buchholtz, and other places. The lace industry has more especially its seat in Saxony, where it forms an important occupation of the women of the country, and produces the various descriptions demanded by fashion. The different kinds of lace made are Mantilly, Mechlin guipure, and Valenciennes. In addition, there are made from cotton, as well as silks, capes, pellerines, parasol covers, veils, and similar articles. Machine-made lace and embroidery are principally made in Plauen, and are largely exported. The manufacture of curtains is carried on to a large extent.

THE ORANGE TRADE OF JAMAICA AND FLORIDA.

In a recent number of the "Bulletin of the Botanical Department, Jamaica," some facts are given on the subject of the importation of oranges and lemons from Italy into the United States of America. Of course it is well known that large crops of oranges are now grown in Florida, but it is stated that, before the Florida crop assumed t large proportions it has in recent years, the Unit States depended in a considerable measure up Italy for supplies; and as the fruit from that coun is of a desirable quality, is carefully packed, and carried in steamers specially adapted to the purpo there is still a considerable quantity taken to t American market in the latter part of the wint March to May; but, to do this profitably, deper in a great measure whether supplies from Florida f off, as they usually do at that time of the ye Jamaica fruit, or any other fruit of equal quali would sell as well, but, unfortunately, the Jamai fruit is not carefully selected and sized, and t quality varies very much. The Italian fruit ru even, is quite free from drops and thorned orang and reaches New York in boxes containing r spectively 160, 200, 240, and 300, according to gra or size.

Lemons grown in Florida are not of good qualit They are large, thick skinned, and perishable; co sequently, the bulk of the fruit used in America derived from Italy, and they arrive in boxes of 24 300, or 360 each, all of even size.

If Jamaica oranges were properly cultivated, ar as carefully packed as Italian, there seems to be r reason why they should not find as good and ready a market.

Reporting to the Director of Public Gardens ar Plantations in Jamaica on the condition of the orang crops in Florida during the past winter, Messr Gillespie Bros. and Co., of New York, say that, consequence of the exceptionally cold weather wi which Florida was visited at that early part of t present year, this year's orange crop was near ruined; but a second visitation of cold in Februa was much more severe, freezing temperature lastir several days, and thus has not only completed t ruin of the present crop, but has also serious damaged the trees, especially the young ones, whi will have to be cut down, and their production d layed for several seasons. This means, at least, th next year's Florida crop will be a very small one, ar it is not likely, under more favourable circumstanc to assume the proportions of the last few years f several seasons to come. A good market for Jamai fruit may, therefore, be expected all next winter, an possibly, for several winters to come, so that it w be to the advantage of orange growers in Jamaica give attention to the improvement of quality, and care in packing. For this purpose it is recommend that, as the Florida fruit finds its way to the Ame can market regularly sized, and the number oranges printed on the outside of each package, would be well for the Jamaica growers to use Ame can signing machines, which would materially ass in economical handling, and ready sale on arriv There seems to be a difference of opinion wheth thick or thin-skinned fruits travel best, and al whether the fruits should be gathered before they a ripe, or when fully ripe, though it is agreed that aft

ıthering the fruit should be kept in the shade, or in cool room for about 24 hours. The fruits should ; cut, and not pulled from the tree, and care should ; taken not to bruise them. The careful wrapping paper is described as being very important.

In connection with the orange culture in Florida, [r. Vice-Consul Howe, of Pensacola, has just re- orted to the Foreign office as follows:—"The im- ıense orange trade of Florida is from the more outhern and middle parts of the State. At Pensa- ola and around here are some of these trees, but anges are not cultivated in this part of Florida for ie fruit trade. Extreme cold, which is sometimes xperienced at Pensacola during the winter months, as, from time to time, seriously damaged the orange ees at Pensacola and its surroundings. Just at the ose of the year 1894, a 'cold wave' passed over lorida which, it is said, has been the coldest weather xperienced since 1835. A record of the thermo- ıeter on that occasion showed Pensacola 14°, at ther places in Florida, 10°. The destruction of the lorida orange crop by this cold weather is reported) have affected not less than 2,000,000 boxes of ranges, or more than half the present crop, which ere frozen on the trees.

Correspondence.

THE COMING RAILWAYS OF INDIA.

Having read with great interest Mr. Parry's paper n "The Coming Railways of India," I shall be glad) be allowed to make a few remarks thereon. Mr. arry groups the "coming railways" under two eads—(*a*) first-class investments; (*b*) sound second- ass investments. The first of these he describes as gilt-edged securities;" but he does not say what terest they would pay on the capital necessary for ıeir construction. The railways under this head are -in Mr. Parry's opinion—four in number, three of hich, he is of opinion, the Government of India ill not allow to be constructed by private enter- rise. The fourth, he thinks, the Government of ıdia would willingly allow private enterprise to onstruct. But why? Mr. Parry does not say; nd, personally, I feel some doubt as to the accuracy f his opinion. Mr. Parry calls his second-class ıvestments "sound," but does not say what dividend e would expect them to pay on the capital invested.

I believe that nearly all—if not quite all—the lines ıentioned by Mr. Parry would pay, and pay well, constructed economically, and worked without exatious restrictions.

The reason why railways are not constructed in ıdia by private enterprise is not because paying nes cannot be found, but because the English ıvestor has a deep distrust of the Indian Govern- ıent. For many years past it has—where railways re concerned—worked on the principle, "heads, I win; tails, you lose." If a promoter tries to take up any line that has a future, he is met at every stage with difficulties. The concession is limited to an absurdly short term of years, vexatious and unreason- able restrictions are imposed, and, in the end, he finds the terms such that it is impossible for him to raise the necessary capital.

In a letter, published in *The Engineer*, on the 29th December, 1893, I pointed out some of the faults in the so-called concessions, formulated in the Government Circular, No. 924R, of 15th September, 1893. Only one of these concessions was new, and that one was useless. The rebate offered was so small (only 10 per cent. as a maximum on the gross receipts of the traffic interchanged between the main line and the branch line) that in many cases it amounted to no guarantee at all.

But this is not the worst. The guarantee offered is radically wrong in principle. A sliding guaran- tee, to be of any practical use, must increase in value, within a given limit, in direct ratio to the needs of the guaranteed. This rebate guarantee does the exact reverse of this. If the "branch" line is carrying a large and profitable traffic, the rebate would, no doubt, be of considerable value; but under such circumstances the branch line would in all pro- bability not require any assistance in order to pay 4 per cent. on its invested capital. On the other hand, if the "branch" line was a failure, if its traffic was small and valueless, the rebate would be smaller and less valuable, and the owners of the "branch" line would receive practically no assistance whatever. It is hardly possible to suppose that the authorities at Simla are unaware of this, and it is quite impossible to suppose that the astute financiers of Lombard-street would be misled by a guarantee of this nature.

I believe that if the Government of India are in earnest in wishing railways to be constructed in India by private enterprise, it can get every line that has any prospects of paying 4 to 5 per cent. on the necessary capital constructed without difficulty, pro- viding the terms offered are reasonable. The land must of course be given free, as heretofore, and, in order to reduce first cost, assistance must be given in making the preliminary surveys, and in compiling the necessary statistics.

Material must be admitted free of import duty and carried at reasonable rates over State lines. The concession must mot be limited to the absurdly short period of ten, fifteen, and twenty years, and the company must not be hampered with vexatious re- strictions as to rates of fares, freights, &c.

It is absurd to suppose that English investors—the most energetic and enterprising in the world—will refuse to put money into an undertaking that has every reasonable prospect of paying 4 to 5 per cent. on the capital invested, and that is situated in a de- pendency of the British Crown, enjoying a strong and settled Government. If the estimates of the cost of construction, probable traffic receipts, and working

expenses are correct, there must be something very much at fault with the terms offered, if English financiers refuse to touch it.

What that something is it is not difficult to say. The truth is, the Indian Government does not wish lines to be constructed by private enterprise. It has a very valuable monopoly, and it is by no means anxious that outsiders should interfere with its profits, or take the good things it hopes, in a few years, to appropriate to itself. Such feelings are, under the circumstances, natural, but it seems a pity that the Government does not openly avow them, and thus save many would-be promoters from the loss of money and time, and the vexation of spirit that is the only result of the existing system.

Mr. Parry makes one statement in his paper which I think requires modification. He states that one of the reasons why railways pay so well in India is that "labour is plentiful." This statement appears to point to a confusion of ideas. Labour in India, as measured by the wages paid, is *cheap*, but cannot be called "plentiful." Plentiful is a relative term, and means, in the sense in which Mr. Parry uses it, that the supply of labour is greater than the demand for it. There are no labour associations in India, and it is impossible, therefore, to give figures to show what proportion of men in any trade are out of work at any one time. But my experience goes to show that while labour in all trades is, as compared to Europe, and as measured by the wage paid, cheap, it is by no means plentiful; in fact, in many districts—and this is particularly the case in the districts through which pass the two first-named of Mr. Parry's "first-class" lines—so far is labour from being plentiful, that it has to be imported. There are, in fact, statements in Mr. Parry's paper which go to show that, although he has himself found labour cheap, it has been by no means plentiful.

He says that, on one railway on which he was engaged, coolie labour rose from $1\frac{1}{2}$ to 4 annas per day; and that, in another case, an offer of 12 annas per day failed to attract labour, "because the climate was unhealthy." Are wages likely to increase 266 per cent. in twelve months? Are men likely to refuse to work for any wages that may be offered, when labour is plentiful? I think not.

My experience is, that no men are so independent, as a body, as the Indian labourer and artisan. The reason is that, almost without exception, the individual is not only a labourer or an artisan, but is also an agriculturist. If he fails to get work suited to his ideas, he does not starve; he simply returns to his home, settles down on the piece of land that has been in his family for generations, assists in its cultivation, and lives on its produce.

In a society constructed on this system, labour may be cheap, but is hardly likely to be plentiful, except in time of famine, or under other abnormal conditions.

J. Forrest Brunton,
Assoc.M.Inst.C.E.

Karachi, June 3, 1895.

General Notes.

Submarine Cables.—The total length of all cables laid up to the present time is about 157,; nautical miles. Most of these cables have only c core, but some have two or more. The total leng of core in the above-mentioned length of cables about 166,900 nautical miles. Of this length, 165,c is insulated with gutta-percha, and 1,900 with ind rubber. The approximate weight of gutta-perc used in the above insulation is 23,000 tons for t 166,900 miles. The approximate weight of ind rubber is about 152 tons. Besides the above-me tioned submarine cables, there must be some 100,c nautical miles of cable, laid by various Governme and States for military defence. The longest stret of cables are, of course, those running across t Atlantic to North and South America, and t shortest across the English and Irish Channe and between Java and Sumatra, and Athens a Corinth.

Goldsmiths' Company.—Sir Frederick Ab Vice-President of the Society of Arts, has ju succeeded to the office of Prime Warden of t Goldsmiths' Company, and Sir George Birdwoo in proposing his health, at the dinner of the Co pany on the 19th instant, said:—"Let me add th my gratification in being here to-night is immense enhanced by the presence of Sir Frederick Abel the chair as Prime Warden. As the result of ma years' close official relation with him I can empha cally say that there is no public man for whom it possible to entertain greater admiration and rega A distinguished scientist, and an experienced offic of the highest reputation, when on retiring from t public service he might have been well content pass the rest of his life in dignified ease, he, wi characteristic self-sacrifice, accepted the truly Herc lean task of founding and organising the Imperi Institute. It is in connection with this heroic unde taking that I have been most intimately brought in contact with him, and learned to appreciate som thing of the far-seeing and far-reaching purposes national and imperial advantage which he has view in gradually shaping the Imperial Institute f the due discharge of the weightier and more bene cent uses he designs it to subserve. It is in th association that I have also observed the energ courage, and devotion with which he applies hims to every duty in which he is engaged, and his mo generous helpfulness and absolute loyalty toward who have directly or indirectly to co-operate wi him in any cause. However imperfectly I may ha said it, I have said enough to indicate to so co siderate and sympathetic an audience with wh warmth of personal affection and pride of patriotis I now call upon you, gentlemen, to drink the long life, health, and happiness of the Prin Warden."

Journal of the Society of Arts.

No. 2,224. Vol. XLIII.

FRIDAY, JULY 5, 1895.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRACTICAL EXAMINATIONS IN MUSIC.

The practical examinations in Music were ot concluded this year in time for the results o be included in the Report of the Council hich appeared in last week's *Journal.* There ere 390 candidates, an increase of 11 over ast year, of whom 59 failed to pass: 17 candiates took up two subjects, so that there were 07 examinations; 90 first-class certificates ere awarded, and 239 second-class. Fifteen edals were awarded to those candidates who btained full marks. The following were the ubjects:—Piano, singing, violin, organ, harp, ioloncello, and cornet. Mr. John Farmer, of alliol College, Oxford, and Director of the arrow Music School, acted as Examiner, and Ir. Ernest Walker, M.A., Mus. Bac., as ssistant-Examiner.

EXAMINATIONS, 1896.

The dates fixed for the Society's Examinaons in 1896 are—Monday, March 23rd, uesday, 24th, Wednesday, 25th, and Thursay, 26th.

The Programme of Examinations is in course f preparation, and will be issued shortly.

Proceedings of the Society.

TECHNICAL EDUCATION CONFERENCE.

A conference of representatives of Technical istruction Committees of the various County ouncils and others interested in the subject onvened by the Council was held on Thursay afternoon, June 20, 1895; Major-General Sir John Donnelly, Chairman of the Council, in the chair.

Among those present were the following members of the Society of Arts Committee:—Captain Abney, C.B., F.R.S.; Lord Belhaven and Stenton; M. Carteighe; R. Brudenell Carter, F.R.C.S.; Sir Charles Kennedy, K.C.M.G., C.B.; W. H. Preece, C.B., F.R.S.

Also the following:—W. Bousfield, City and Guilds of London Institute; R. Palmer, City and Guilds of London Institute; George Shaw, City and Guilds of London Institute; A. L. Soper, Assistant Secretary, City and Guilds of London Institute; Wm. Garnett, London County Council; C. James, London County Council; David Laing, London School Board; John Sinclair, London School Board; Albert E. Briscoe, Battersea Polytechnic; D. S. Capper, King's College; Wm. H. Congreve, Birkbeck Institution; J. B. Edmond, Printer's Association; C. R. Hodgson, College of Preceptors; R. G. Hodgson, Crystal Palace Technical School; Miss M. S. Kilgour, Women's Local Government Society; J. Logan Lobley, City of London College; Miss F. Martin, College for Working Women; C. T. Millis, Borough Polytechnic; F. Oldman, National Association for Promotion of Technical and Secondary Education; Wm. Ping, Deptford Technical School; J. S. Redmayne, Goldsmiths' Institute, New Cross; D. Savage, City of London College; E. White Wallis, Sanitary Institute; Sidney H. Wells, Battersea Polytechnic; T. C. Abbott, Manchester; W. Banister, Devonport; A. J. Baker, Leicestershire; J. A. Bennion, Lancashire; Jeff J. Broomhead, St. Helens; F. N. Cook, Wakefield; Thomas Cope, Leicester; C. H. Corbett, Wiltshire; David Cowan, Hampshire; F. W. Crook, Kent; A. Dean, St. Albans; Wm. Dunstall, Chatham; A. P. Freeman, Brighton; S. Maudson Grant, Lindsey; P. Hawkridge, Derbyshire; Jos. R. Heape, Rochdale; W. Hewett, Liverpool; Henry Hill, Swindon; C. Courtenay Hodgson, Carlisle; J. N. Innes, Aberdeen; J. A. Jenkins, Cardiff; J. W. Jones, Rochdale; A. Keen, Cambridge; Major-Gen. C. E. Luard, Kent; Wm. Lees McClure, J.P., Lancashire; Wm. Malcolm, Lanarkshire; H. Macan, Surrey; W. Keatley Moore, Croydon; E. Pillow, Norwich; W. T. Pycraft, South Bucks; Charles E. Rainbow, Coventry; E. Rainbow, Coventry; J. H. Reynolds, Manchester; Evan W. Small, Newport; Thomas Snape, M.P., Lancashire; F. Spooner, Bedfordshire; W. Sendall, Brighton; Francis J. Smith, Hunt-

ingdon; R. J. Somers Smith, Surrey; John Spiller, Essex; W. H. Stour, Gloucester; C. H. Stevenson, Stafford; Henry Tanner, St. Leonards-on-Sea; G. S. Turpin, Huddersfield; Rev. J. S. Warren, Lindsey; F. Wilkinson, Bolton; C. H. Williams, Northumberland; John Woolman, Watford; Frank Woolnough, Ipswich; Dr. Yeats, Newport; Francis Ashby; Col. C. E. G. Burr; J. R. Barratt; Alan S. Cole; J. E. Dowson; Major-General E. R. Festing; Francis Fladgate; F. R. Fowke; Alfred E. Garrard; S. M. Grant; G. Gerraillier; Claude Hudson; R. E. Hughes; H. C. Jenkins; E. J. E. Maitland; L. J. Mallet; H. J. Powell; T. A. Reed; A. R. Willis.

The CHAIRMAN, in opening the business, said he proposed to make a few introductory remarks to explain the position of the Society of Arts in this matter. The history of the Society which, with the exception of the Royal Society and the Society of Antiquaries, was the oldest society in the kingdom, showed that from its earliest days it had employed itself in initiating movements which, when they had developed, were taken up by bodies specially created to forward them, and when that occurred, the Society of Arts had most willingly handed over any interests it might have in the matter to the society which had been specially formed to carry it on. Possibly some present were not aware that even the Royal Academy had its commencement in Exhibitions held in the Society's rooms which, after being carried on for two or three years, were found so successful that the artists combined to form the Royal Academy. Again, the Society did much in the early days in elementary education, forwarding it by various means, by conferences, examinations, and prizes. The Science and Art Department with which he was connected may be said to have had its origin in the examinations in science and in art which were instituted by the Society. Again, in its early days the Society of Arts devoted a great deal of attention to agricultural subjects, agricultural machinery, forestry, and such like. It had also, at various times, furthered—by exhibitions, papers, conferences, and prizes—various subsidiary arts, such as aquatint, mezzotint, engraving on steel, lithography, metal chasing, and so on; and all these matters were now included under technical instruction. In all these cases the Society acted as as a pioneer. Thus, when the Science and Art Department was established, and had Government funds at its back, the Society of Arts ceased its examinations in science and art subjects. But in 1872, the Society instituted examinations and prizes in technology, being aided in its earliest efforts by some of the City of London companies; and when, a few years afterwards, it found that the City and Guilds Institute of London were prepared, with the large funds at their disposal, to forward instruction in technology, by holding examinations and making payments on the results, the Society of Arts gladly handed over its system of technological examinations to the City and Guilds Institute. That system of examination by the City and Guilds of London had now become an established, and, deservedly, highly appreciated institution; and he wished to make it quite clear that the Society did not want in any way to interfere with what the City and Guilds, or any other similar body, was doing. It simply desired now to take the opinion of that Conference upon the question whether it should extend its present operations. When the City and Guilds of London took over the technological examinations, the Society still continued its examinations in commercial subjects, in domestic economy, and in music. But there was still a wide range of subjects besides those covered by the City and Guilds, and by the Society, which as far as they were aware, were not covered by the examinations or inspections of any other body. Papers had been distributed giving a list of all the subjects of technical instruction which had been sanctioned and passed by minutes of the Science and Art Department, on the application of local authorities, showing in which of those subjects examinations were held by the different examining bodies, and from this it would be seen that, broadly speaking, all those minor subjects of agricultural instruction, and all the subjects of home arts and industries were untouched. It had been suggested that the Society of Arts should extend its system of examinations to include these subjects, as it was found that the certificates awarded to successful students were a great stimulus, and were highly appreciated, while the general results of the examinations were of use to local authorities, by affording them a means of judging how the instruction was being carried on, in relation to other districts. It was also suggested that the Society should provide, when asked, technical inspectors, who could be employed by the local authorities to report on their classes in special subjects. These suggestions having been brought to his notice on several occasions, he submitted the question to the Council of the Society, after having discussed it to some extent in his address at the opening of the session. The Council at once came to the conclusion that they would support it as far as their means and power permitted, if it was considered desirable in the country generally that they should do so. His idea at first was rather in the direction of trying to establish a joint examining and inspecting board, formed by representatives from the various examining bodies and the local authorities—not necessarily that this joint board should meet in that place, or that it should be at all under the wing of the Society, but simply that the Society should take the initiative in the establishment of such a board, so as to co-relate the work of the different examining bodies to prevent friction or overlapping and to conduce generally to unite the action. However, difficulties had arisen to going as fa

as that at once. It might come eventually, but at present the business of the Conference had narrowed itself to the point of deciding whether, in its opinion, the Society ought to cover the ground which was not covered by other bodies in the way of examination or inspection. It was for the meeting to say whether they wished it or not. He need scarcely say that if they did not wish it, the Society had no desire to spend its money in establishing a system of examinations which no one wanted; and, further, he was quite sure that even if examinations were established; if there were any other body which was better furnished with means than the Society, and could conduct them more efficiently in certain subjects, it would be most ready to hand those examinations over to such body on the first application. With the view really of getting the opinion of the meeting, certain resolutions had been drafted. If they were adopted, the Society would know how to act, and if they were rejected, no harm would be done, but he wished it to be clearly understood that, speaking for the Council, they did not wish to compete with or to supersede the action of any existing body. He thereupon moved the first resolution:—"That it is desirable that the Society of Arts should extend its system of examinations, and provide for examination and inspection in those subjects which are not taken up by other bodies."

Sir Charles Kennedy, K.C.M.G., C.B., said he had much pleasure in seconding the resolution. While the subject had been before the Council he had made inquiries in different parts of the country as to the views taken in connection with it, and had learnt that the opinion was entertained very generally that technical teaching, unless it was followed by inspection and by examination, was not of much practical value. He, therefore, thought the subject was well worthy of consideration. A system of inspection was of value, both to the teachers and to the students. If established, it would further lead to some degree of uniformity in teaching. Examinations were chiefly of value to the students themselves in showing the practical results of the teaching afforded them; but the value of the examination was much increased if in certain localities prizes—not necessarily of large value—were assigned, in order to bring the examination up to a certain standard. He would not enlarge further upon the resolution. The main object of the Council was to elicit the opinion of those who attended the Conference, and whatever the immediate results might be, he trusted it would ultimately tend to the improvement of technical education, which was the chief object the Council had in view.

Mr. W. Bousfield said, representing the City and Guilds Institute, he was asked by the Executive Committee to attend the Conference, in the first place, to express their sense of obligation to the Society and Sir John Donnelly for the work they had done in the past in the promotion of technological examinations. People's memories did not go very far back, and there might be many persons present who did not recollect that the system of technological examinations of the City and Guilds Institute, which had now spread so widely, really took its rise with the Chairman. He saw how desirable it was that there should be some means of testing the works of the various classes in technological subjects; and throughout the country the Society of Arts, with the aid of the Clothworkers' Company—of which he (the speaker) was a member—started those examinations, which were subsequently handed over to the City and Guilds Institute. All those who had watched the progress of technical classes throughout the country must have felt that great progress had been made during the last twenty years; in fact, the technological examinations of the City and Guilds Institute were now spread, not only throughout the three kingdoms, but in the Colonies, India, and almost every place, except the United States, where the English language was spoken. But his committee, when they received notice of this Conference, whilst they were exceedingly anxious to support the Society in every way in securing that examinations should be held where they were wanting, felt that it would be a very serious hindrance, not only to their work, but to the progress of technical education throughout the country, if any organised body were interposed between them and the local classes and the County Councils, with whom they dealt directly, and though he was averse to move any amendment, particularly after the strong expression from the Chairman that there was no intention whatever to interfere with any existing bodies holding examinations; still, he thought the first resolution was so worded as to certainly lead to the impression that the technological examinations of the City and Guilds Institute had failed to meet the demands of the country. It would have been impossible to foresee, when they were started, the very large additions which were yearly being made to the list. Every year saw the addition of one, two, or three different branches of examination, and it had been found necessary, even when the examinations were not increased, so to subdivide them that they were becoming yearly a much larger number. Sir Philip Magnus told him that, taking the subdivisions at present, examinations were held in some 80 different subjects by the City and Guilds Institute. Since the allocation to the County Councils of large sums for the purpose of technical education, the importance of these examinations had been still further increased. Up to that period, the City and Guilds Institute had been granting payments by results to the successful students in the classes; but it was felt, when these large sums were in the hands of County Councils and local bodies, that they could very properly use them for subsidising the individual classes in their districts, whilst the money of the City and Guilds Institute would be better employed in perfecting the system of examinations, and in adding a system of inspection, which

all those who had followed the subject must feel was as important, in many ways, as examination itself. They were in progress of development; they hoped to add to the examinations they had at present, and to perfect them still further, and also to be able to do for other counties what they had done for a large number of localties—for the West Riding, Surrey, Essex, Hampshire, Bristol, and, in some respects, also for Birmingham—to send highly trained inspectors to inspect the schools, and to report to the county and municipal counties whether those schools could be improved, and how far they deserved the very liberal grants now being given to them. He should be very sorry to see any curtailment of development in the future, but he thought if they were to pass a resolution that the Society of Arts should take up the whole field which was not at present occupied by the City and Guilds Institute, or any other body, that they would be undoubtedly hampered in the future. When the second resolution came to be moved* he should have to point out also that that would affect the development of the City and Guilds Institute; but he would strongly urge the meeting not to pass a resolution which would give any countenance to the Society of Arts or any body stepping in and dividing the responsibility which the City and Guilds Institute now had. Nothing could be more inconvenient than that a clearly defined group of subjects, such as those referring to the trades of England, should be in the hands of more than one body. He thought that the City and Guilds Institute, with its experience, and with the aid of the distinguished professors of its important colleges, at Finsbury and South Kensington, who formed the Consultative Examinations Board, was as well able to deal with these trade subjects as any body in existence. Of course the subject was a very big one, and it was quite possible that these examinations might be considered so important that they should be taken over by the Government; but in England they did not do everything in a thoroughly centralised way, they relied a great deal on private and corporate bodies to step in and do work which in some countries would be done by the State. There were many advantages in that system, and as far as it applied to present practice, it had answered very well. The amendment he proposed to move was this:—"That it is desirable that the Society of Arts shall extend its system of examination in commercial subjects, and that the City and Guilds Technical Institute shall, as the industrial requirements of the country demand, continue and extend the development of its technological examinations, and the inspection of technical classes on the lines on which this has been successfully done in the past."

* The proposed second resolution was as follows:—"That it is desirable that the Society of Arts should arrange for an office and central organisation, from which information, advice, or assistance might be obtained, and through which arrangements might be made for inspection and examination."

Mr. R. Palmer, in seconding the amendment, said he was glad to hear from the chair that there was no desire on the part of anyone to interfere with the work which any recognised body was now doing. He should like to emphasise what had been said by Mr. Bousfield, that it was most essential in their view that a body which had been at work now for a great many years, and which had arisen in response to a national demand, and had the direct support of County Councils and municipal authorities throughout the kingdom, should not be interfered with in those well-ascertained groups of subjects which it had taken up in connection with industrial employments. He thought it would certainly be a dangerous thing if any resolution were to be passed which would exclude them in the future from those subjects which they had not yet been able to deal with. They deprecated anything like a scramble for Africa in those parts of technology which were not yet occupied. What the Chairman had said showed very strongly that the Society of Arts had already in their goodness—having handed over certain subjects to the City and Guilds Institute—adopted for themselves examination and inspection in commercial subjects. There were many subjects other than commercial subjects which a body like the City and Guilds Institute had not dealt with, and which were taken up by the Society of Arts, and everything which would induce the Society to continue the commercial branch, and any other branches of technical teaching, whether commercial, industrial, or national, as the case might arise, they would be glad to see; but they did deprecate the use of the words, "such subjects as are not now taken up," which were terms of exclusion that might be embarrassing in the future. He would remind the meeting that the City and Guilds Institute, when first formed, included no less than 44 companies, with divers objects and interests, joined together to promote the applications of the principles of science and art to industries and employments. Everyone of those 44 companies had a great number of members, each advocating the trade or business in which they were interested, and therefore there was no fear whatever of the City and Guilds Institute, so long as its funds enabled them to continue, withdrawing its hands from that sphere of subjects with which it already dealt and extending them still further. Again, the number of the examinations and the students in the classes was worth remembering. There were 26,000 students in classes carried on under the direction of the City and Guilds Institute, and 12,000 under examination, many of them in Scotland.

The Chairman said he did not know whether he had made himself clear, but he had intended to do so, that it was not suggested that the Society of Arts should touch the technological examinations on subjects which the City and Guilds of London had

ken up. He supposed this amendment was meant to express the opinion of the meeting that it was not desirable that the Society of Arts should take up examinations in agricultural subjects, or in the home industries.

Mr. J. H. Reynolds (Manchester) said he was sure he expressed the opinion of every one present when he said that throughout the country there was the deepest feeling of gratitude towards the Society of Arts for the eminent services it had rendered over a long period in the encouragement of arts, manufactures, and commerce; but to-day they were in face of a practical question of very grave importance to those concerned with the administration of technical instruction. The resolution had, he thought the fault of being too wide and too inclusive. They were in danger of what already existed to an undesirable extent in teaching, namely, of overlapping in examinations, and that was a danger which should be sedulously guarded against. The City and Guilds Institute had been engaged in technological examinations over 16 or 17 years, and he had been actively associated with it so far as the manufacturing industries of a large city were concerned. This resolution had reference, he apprehended, to the long list of subjects detailed on the circular which had been distributed, and he noted that there were some 68 subjects which were not provided for by any system of examination. But when the subjects were carefully gone through it was clear that, as regarded more than half, they would probably come within the sphere of the examinations of the City and Guilds of London Institute. Certain others, it seemed to him, properly belonged to the Science and Art Department, especially having regard to the fact there had been new regulations proposed whereby objects might be sent up for examination, in which the designs of the students were worked out. That provided for a series of examinations in art work, porcelain, glass, textiles, and many other subjects of the like kind. He thought it was most important that they should keep as distinct as possible the means of examination and of inspection. There was no objection to the Society of Arts increasing the number of and developing its very important commercial examinations, but the City and Guilds Institute should be allowed to develop, as time went on, the various examinations connected with trades and industry. This must, necessarily, be a slow process. Some of the subjects named in the list had been in former times upon the programme of the City and Guilds Institute, but it was found impossible to get classes together in sufficient numbers, and next to impossible to get students to enter for the examinations. This could only be done by degrees, as the need for examination was recognised by those belonging to the various trades and industries. Then the very important question of agriculture should be relegated to bodies having special knowledge of the subject, as, for example, the local university colleges existing in various parts of the country, or the Royal Agricultural Society. He could not see how an institution centered in London could possibly give the assistance, in the way of information and advice, and supply the means of examination, now available in the various important localities throughout England. He quite accepted the Chairman's statement that there was no idea of interfering with the work of other institutions, but, it must be remembered, that there existed in various parts of the country very important local bodies. There was, for example, the Lancashire and Cheshire Union of Institutes, which this year examined the work and papers of 27,000 students. It was the object of that Union to concern itself mainly with the elementary parts of technical, commercial, and agricultural subjects, the idea being to leave the more advanced students to attempt the examinations of some national body, whether the Science and Art Department, the Society of Arts, or the City and Guilds Institute. That Union refused to go outside its own borders, but it advised the Midland counties to establish a Midland Union, and he had no doubt that example would be followed by other important centres. These local unions were on the spot, they knew better the local needs, and they could do a great deal in securing this very system of inspection which was so important in controlling the work of Technical Instruction Committees; so that, in any proposed new schemes, they ought to have regard to the work of these Unions. He thought this was a subject not for resolution, but for inquiry. It by no means lay in a nutshell. To examine students in the various trades and industries who entered the classes, and to secure really valuable inspection, was no easy matter. The Science and Art Department, with all its prestige, had not yet secured the means of satisfactory inspection of the numerous classes under its control. How, then, was the Society of Arts, or any body to be created at the moment, to establish a thorough system of inspection which would largely dispense with examinations? He thought it would be desirable to pass a resolution, asking the important bodies concerned to appoint representatives to meet together to inquire and report what was best to be done. The time had come when there should be some opportunity for the graduation of carefully prepared technical students, but no such opportunity existed now. There were, in the evening classes of great towns, young men thoroughly skilled in their particular industries, who had far better knowledge of the science of those industries than many men who possessed the degree of B.Sc. had of science, but there was no formal means of recognising thi skill and knowledge. There was no opportunity for such a man to show that he was qualified as a graduate in technology, that he knew his business as an engineer, or that he was a skilled practical chemist, or an expert in the textile industries. Had not the time come to institute such a scheme of

examinations as would enable an artisan thoroughly prepared in the science of his business to qualify as a graduate in technology, by means of instruction in evening classes. This might be considered a very important part of the business of such a committee as he proposed. He begged to submit an amendment to the resolution.

The CHAIRMAN said it would be better to dispose of one amendment first.

Mr. REYNOLDS said his amendment was rather wider than the one now before the meeting, and perhaps Mr. Bousfield might accept it as better covering the ground.

The CHAIRMAN said it might, perhaps, be as well to read it.

Mr. REYNOLDS then read the amendment he proposed as follows: "That in the opinion of this meeting it is desirable that provision should be made for examination and inspection in the subjects of instruction undertaken by Technical Instruction Committees, but not at present included in the schemes of the Science and Art Department, the City and Guilds of London Institute, and the Society of Arts; and with the object of giving effect to the same a Committee, composed of the representatives of the Science and Art Department, the City and Guilds of London Institute, the Society of Arts, the Technical Instruction Committees, and of the Royal Agricultural Society, be appointed to draw up a report, and to prepare recommendations on the whole subject."

Mr. BOUSFIELD said there was a great deal in this amendment with which he agreed, but it seemed to him that, unless they heard from the Society of Arts, and perhaps from other bodies, that they were willing to concur in such an inquiry, it would be scarcely worth while to pass it. If the Society of Arts was willing to concur, personally he should be glad to support it.

The CHAIRMAN said it was impossible for him to answer even for the Society of Arts at the present moment. He thought they must dispose of the first amendment first.

Mr. J. S. REDMAYNE said he had found some difficulty some time ago in getting an examination in dress-making of any kind whatever till the City and Guilds authorities came to the rescue; but his chief object in coming was to endeavour, if he could, to get three examinations instituted, either by the City and Guilds or by the Society of Arts, namely, one in cookery, another in art needlework, and a third in wood-carving. These were three subjects which were not dealt with by any body at present. Both needlework and wood-carving were important subjects, but his chief object was to get an examination in cookery which could be entered into by the poor people. The only examination now was one of very expensive nature, that of the Royal School Cookery, which was entirely unsuited for Sch Board teachers and others of that class who desi to obtain a diploma in cookery as a separate su ject. He knew, from five years' experience technical classes at an institute where there we over 2,000 female students, that the chief drawba they found to getting successful classes in cooke was the want of a diploma by examination at the e of the course.

Mr. FRANCIS ASHBY supported the amendme because he thought it would be fairly easy to define t work of the two bodies. The industrial subjects und taken by the City and Guilds Institute would cov all industrial occupations for the pure constructi for the needs of human beings. Art began at certain point where industry might be said to en All the technical industries had reference to t necessities of life, and they should be left to the Ci and Guilds, while the Art Department should ta up those things which were, in some measure, supe fluities. He thought it would be a misfortune f the Society of Arts to take up the line of work which the City and Guilds were engaged.

Mr. BOUSFIELD asked if it would not be possib to modify the original resolution, with the consent the Chairman, in such a way as to make it quite cle that the City and Guilds Institute would be allow free development within the lines it now occupied.

The CHAIRMAN said he thought it was scarce necessary to ask that question. Considering th examinations which, as Mr. Bousfield had already i formed them, had been started by the Society of Ar were handed over, without the slightest difficulty, the City and Guilds Institute, he could not concei why the Society should at any time attempt to ta any of them back, or to cover the field which w appropriate to that Institute in any way whatev If he might venture to prophecy, he should s that, if at any future time the City and Guil Institute wished to take over any subject in whi the Society of Arts was examining, he could n conceive that Society having any hesitation in agree to their doing so. That had been the universal pra tice in the past, and he should imagine it would be t practice in the future. He had endeavoured, but appeared unsuccessfully, to make that clear in l opening remarks.

Mr. BRUDENELL CARTER, F.R.C.S., said had listened carefully to the argument of M Bousfield, and it appeared to him that it wou admit of being tersely stated in the form of recommendation that, in such weather as they h been lately having, it would be improper to wa the garden, because at some future time it wou

robably rain. That appeared to be the whole ıbstance of the matter, and the whole objection on ·hich the amendment was based. The Chairman ad made it perfectly clear that what was suggested 'as that unoccupied ground might be covered by ıe agency of the Society; and, judging by the ast history of the Society, it would be glad when ɔme other tiller came forward, and put his hand ɔ the plough, to hand over any such work to im. He could not imagine there being any ·bjection to the Society of Arts doing its best in neglected portion of the field of education ıerely because another body was doing excellent vork by the side of them, and thought at some uture time it might occupy the ground.

Mr. J. SPILLER said having spent three years on he Essex Technical Education Committee, and ıaving taken a very active interest in the inspection ɔf the classes there, he felt that this was a most mportant question, and one on which he should like o throw a little side light. He found that under he heading of science, on the fourth page, item No. 23, was navigation as a branch of science, provided for apparently by the examinations of the Science and Art Department. They had been eaching navigation for three years in the county of Essex, but the students were examined by the Board of Trade, and certificates had been given in several nstances for proficiency to act as a master or subordinate. So that with the possession of a Board of Trade certificate, qualifying a man to go to sea and take command of a vessel, it would surely be altogether unnecessary to appeal to the Science and Art Department or any other to go over exactly the same ground. Then, again, with regard to agriculture, in the county of Essex they taught both the chemical principles as well as the biological side of it, but the examinations were not undertaken by any one of the Departments named, but by the Board of Agriculture itself. That was another instance where the first resolution was inapplicable because the ground was already covered by a large Government Department with which they had no right to interfere. With regard to the *bona fides* of the Society of Arts, and its services in inaugurating this splendid system, he was not to be understood as speaking at all disrespectfully, and he might even add to the Chairman's opening speech that not only was the Royal Academy of Arts born in that room, but another important society, of which Sir Henry Trueman Wood was president, the Royal Photographic Society, was also born there in January, 1853. He had been Inspector of Science Classes in Essex for three years, but his work was now superseded because the classes over which he formerly had authority were allocated either to the City and Guilds Institute, to the Society of Arts, or to the Science and Art Department, or, as he had said before, to the Board of Agriculture, or to the Board of Trade. There was still a little overlapping, particularly in the woodwork division, Slöjd came under one head, and woodwork sometimes under another. One very important matter was this, they were in the habit of enforcing the regulation with regard to the satisfactory illustration of the lectures given, and he was going to make a recommendation to teachers that more use should be made of the national museums, or, in country districts, of the best local museums, taking the students there, and giving them demonstrations, with examples. He could hardly sanction the resolution in its present form, because it omitted all reference to two important Government departments.

Mr. BOUSFIELD said he had reason to believe the Chairman would agree to his amendment, with a slight modification, as follows:—"That it is desirable that the Society of Arts should extend its system of examinations, and provide for examination and inspection in the commercial and other subjects which do not come within the scope of the City and Guilds Institute, and are not taken up by other bodies." So far as he was concerned, he should be pleased to agree to that.

Mr. BRUDENELL CARTER asked how the word "scope" would be defined.

Mr. C. COURTENAY HODGSON (Organising Secretary for Cumberland) said he was prepared to second Mr. Reynolds's amendment, when it came forward, but, in the meantime, he should like to say a word on the first amendment.

The CHAIRMAN said he understood Mr. Bousfield wished to withdraw the first amendment in favour of the modified resolution he had just read, but he must first get the consent of the meeting to this being done.

On being put to the meeting, it was agreed that the resolution, as modified above, should take the place of the amendment.

Mr. HODGSON thought this amendment was really putting the cart before the horse, and going rather too fast. It was quite evident that there was a general feeling in the meeting that they were not in a position yet to pass any resolution going so far as to say that the Society of Arts should extend its system of examinations. He thought they were agreed that a system of examination and inspection was necessary for all education, but they were not all agreed as to the sufficiency of examinations now provided for by other bodies, nor even supposing there were certain subjects not at present covered by examination that the Society of Arts was necessarily the body to examine in them. Without occupying further time he would urge on the meeting to consider, before voting for this resolution, whether careful inquiry should not be made in the

first instance as to whether there were now existing adequate means for all the examinations and inspection required.

The question having again been raised as to the meaning of the word "scope."

Mr. BOUSFIELD said he thought it was perfectly clear the technological examinations of the City and Guilds Institute referred to teaching in connection with various trades and manual construction.

Mr. F. W. CROOK asked if the amendment of Mr. Bousfield, as now amended, was put before the meeting in lieu of the original resolution, or whether it still stood as an amendment in opposition to the motion the Chairman proposed.

The CHAIRMAN said it was moved as an amendment, and if carried as such, would be put as a substantive motion; then it would be open to anyone to move any further amendment upon it.

Mr. LEMAN thought the meeting would like to hear the Chairman's view of the amendment.

The CHAIRMAN said, personally, and he thought he might speak on this matter for the Council also, he did not see the slightest objection to the amendment.

A member of the Conference suggested that the word "responsible" or "recognised" should be inserted before the word "bodies." They did not want to have a number of small local bodies all over the country conducting examinations.

Mr. T. SNAPE, M.P. (Liverpool), said he still thought the modified amendment required more precise definition as to what was meant by other bodies. There were bodies in other parts of the country which covered a great deal of ground which, he took it, the Society of Arts purposed taking under its supervision. If the amended resolution were passed, it appeared to him the Society of Arts would not be able to institute any examinations whatever, because there were bodies here and there which covered the whole of the ground.

The CHAIRMAN then put the amendment, introducing the words "not taken up by any other recognised examining body," and declared it carried. He then read the amendment, as previously moved by Mr. Reynolds, and said of course it was in the power of the meeting to pass this amendment, but he would point out that they had no power to appoint a committee consisting of the other bodies referred to.

Mr. REYNOLDS submitted that the effect of the amendment was that the subject demanded inquiry, whilst the resolution now before the meeting declared that the Society of Arts should proceed extend its examinations into subjects not undertal by other bodies. The meeting might fairly inqu what were those other subjects; for example, in list submitted, bread-making was allocated to the C and Guilds Institute, but baking and confection was at present not undertaken by any body. W the Society to take up bread-baking? That sa principle ran right through the list submitted. also permitted the Society of Arts to underta examinations in design, but he submitted that th were fully covered by the recent action of t Science and Art Department.

The CHAIRMAN pointed out that that subj would be cut out by the resolution as it stood, whi included the words not undertaken by any otl recognised examining body.

Mr. REYNOLDS said the scheme of the City a Guilds Institute potentially embraced many subje not actually undertakeu at the present time, and thought the representative of the society that aft noon ought to bear that in mind carefully. Th had gone on an eminently safe policy of advanci from time to time such subjects as seemed to demanded by the necessities of the various localitie

Mr. HODGSON seconded the amendment. I thought this was eminently a case for inquiry, a did not think they were in a position yet to say th it was desirable that the Society of Arts or any oth body should extend its system of examinatio Speaking for himself and some of his colleagues, th did not know that it was desirable yet. They want to have the whole subject inquired into. It w quite true, as the Chairman had said, they had no pow to appoint this committee; but they had power pass a resolution in favour of such a committee bei appointed, and any resolution passed by an assemb of that kind would, he thought, have some weigl He would strongly urge on the meeting not to pa such a resolution as that before them, but to ado the amendment, and have the whole subject thresh out by a committee who should report to a futu Conference. He was sure they would discover th there were a great many bodies not mentioned the list prepared by the Society of Arts, w had examined and inspected. To take the fi subject on the list, one of those bodies not me tioned was the Board of Agriculture. He himse and many of his colleagues in other counties, h received great assistance from the Board of Agric ture in the way of inspection of agricultu work. That Board had a trained inspector w went down, inspected the work, and presented report upon it. It clearly would not be wise pass that over. There was also, in the sa subject of agricultural science, the Royal Ag cultural Society of England, the Highland Ag cultural Society, and the British Dairy Farme

sociation, all of which held examinations. Be-es these, there were the university colleges and down the country, all of which were fully npetent to both inspect and examine, much more in his opinion, than any centralised body could because they knew exactly the requirements of various trades and industries in their district, l could suit the syllabuses of examination to the of the youths engaged in the neighbouroood. It s absurd to suppose that one syllabus and one ex-iination, in such a subject as mining, for instance, uld be adapted for the requirements of every ning district in England. The mining students in e Midlands would not even understand the terms ed in Northumberland and Durham. He had a ong feeling that a great deal of this work could tter be done by colleges of university rank in the fferent localities; and in other respects uniformity ight be secured by some such system as Mr. eynolds suggested, as was done in the case of the ancashire and Cheshire Union of Institutes or the idland Union that was likely to be formed. He ped the meeting would endorse what Mr. Reynolds ad said, and refer the whole matter to a committee r inquiry.

Mr. C. WILLIAMS said everybody would agree that ie Society of Arts, in convening the Conference, ad been disinterested; that its sole object was to nd out whether its sphere of usefulness could be xtended; and for that reason he rose to support the mendment proposed by Mr. Reynolds, because, it id seem to him, that this was a very complex uestion, and that, in convening the Conference, the Society of Arts had given the opportunity of getting omething done in the matter of organising and ystematising the various bodies conducting exami-iations. Those practically engaged in this work elt that the number of regulations and directories ssued by different bodies which one had to digest vas getting almost unbearable. The City and Guilds nstitute, the Science and Art Department, the Society of Arts and the County Councils all had their lirectories and regulations. If such general inquiry ould be made into this subject it might be possible to arrive at a conclusion which would be generally acceptable to the country. Then there was another aspect of the question which he thought was not quite sufficiently appreciated. While it was perfectly true that there were many subjects at present being taught by County Councils for which no generally recognised agency existed for conducting examinations, there were many subjects in which the work done was too elementary really to come under any one or other of the existing agencies, and yet that particular work required some examination. That question would be dealt with if the amendment were carried. It was a mistake to call the Board of Agriculture an examining body. They did not examine, they simply came and inspected and reported on the work. Then one gentleman had mentioned the subject of navigation and the examination conducted by the Board of Trade. He was afraid there was no recognised authority which could undertake to do the particular kind of work done by the Board of Trade. Many of the men examined in navigation were extremely ignorant; the examination was of the slenderest possible character; many of the men could not write, and it was conducted usually by practical seamen, who could gather at any rate that a man had sufficient knowledge to be accorded a certificate; that was their experience in Northumberland. He wished to emphasise the necessity for further inquiry. It might be found, as Mr. Hodgson pointed out, that they might utilise, with excellent results, the local education agencies, at any rate in the matter of elementary examinations.

Mr. SIDNEY H. WELLS (Principal of the Battersea Polytechnic) said he would add a few words only in support of the amendment. The amendment not only called for inquiry, but he thought it would tend to promote co-ordination, and that was decidedly an end much to be desired at present. He did not know to what extent the Society of Arts, or any other gentleman who had spoken before, had considered the position of the London Polytechnics in the matter. He did not want to claim for them any special virtues or powers, but when those now being built were completed, it was not improbable that they would represent in their students quite three-fourths of the whole evening students in London, and, if that were so, it was quite certain that any system of examination must be of great importance to them. The polytechnics were now concerning themselves very closely with the question of examinations. He was repeatedly asked by students in the classes at Battersea, which were not examined by any recognised outside body, whether he could not arrange some examination for them. The question resolved itself into a still wider one, whether an examination was necessary or even advisable, and how far they should continue to measure the efficiency of their work by examinations. He was not revealing any secret in saying that the London Polytechnics Council, which was a body formed for the co-ordination of the work of all the London polytechnics, was now considering that question, and he imagined that no action would be taken independently of them. The fact that they were considering to what extent it was possible to apply a general system of examination to the whole of the London polytechnics was another argument in favour of the amendment. He did not wish to appear to be acting in any opposition to the suggestion of the Society of Arts; that body recognised that there was some immediate call for action, and had generously come forward and offered to be the moving spirit, and he felt sure they would meet their proper reward, and one which would give them every satisfaction if they could bring about such a Conference as had been

hinted at in the amendment, and as the result of that Conference were able to bring order out of chaos.

Mr. BOUSFIELD said he happened to be a member of the London Polytechnic Council, and the question of these examinations did come forward, and they passed a resolution very much in the terms of that now being moved, that the examinations in commercial subjects should be left to the Society of Arts, and the purely technological subjects be left to the City and Guilds Institute. He admitted that did not touch the more elementary examinations which lay below, and that it was a question for very careful inquiry, but he presumed if this resolution were passed the Society of Arts would be put to inquiry as to how they were to cover the gap which was shown to exist. They could not possibly legislate straight off, without making further inquiry. There were a large number of elementary classes to which it would be absurd to apply a Government system of public examinations, and in which a system of inspection was far better. But he could not help thinking that, if the amendment were passed, they would be shelving the whole subject.

Mr. F. W. CROOK said, in voting for this amendment, he wished to say that his vote was not actuated in any way by hostility to the Society of Arts, nor any want of recognition of the great work it had done in the past; and he was sure his feeling was shared by others.

The CHAIRMAN said, so far as he could gauge the feeling of the Council of the Society, they had no kind of feeling against this amendment or in favour of the resolution. What the Council would like to know was whether the Conference desired they should go on and cover the unoccupied ground, or whether they should defer the matter, and try and collect a committee to consider the matter. He could safely say, for the Council, they had not the slightest feeling one way or the other. The only other point was, that the amendment necessitated shelving the matter for a certain amount of time.

Mr. CROOK said he thought it would be an unpleasant task for the Society of Arts to take this matter in hand entirely on its own account, when it could have the ready and willing assistance of the other bodies, who knew equally well about the matter, and who, by conferring together, could put it on a very much better footing than it would be if left entirely to the Society of Arts. It just came to this, that the Society of Arts now proposed to occupy the ground which had not hitherto been occupied, and the amendment simply went to this, before you occupy ground find out whether it is already covered.

Mr. W. LEES MCCLURE asked if the Society of Arts would try to get a committee together from the bodies named in the resolution. If that were understood, he thought the amendment m[ig]ht be passed, though possibly the wording might [h]e to be changed, so that the Society of Arts sh[oul]d call the committee together.

Mr. H. MACAN (Surrey) suggested a modifica[tio]n of the words of the resolution, which would meet [th]e objection just raised, viz., by the insertion in [th]e middle of the amendment the words, "This C[on]ference recommends that there be formed a c[om]mittee composed of representatives," &c. He thou[gh]t that would meet the technical objection, which [wa]s really the only objection to the proposal.

The CHAIRMAN said he would suggest fur[the]r that the bodies to whom they wished to ap[ply] should not be named, because it tied them up [to] certain bodies, and there might be others, who[m it] would be desirable to consult, which they did no[t at] the moment know of. He thought it would [be] better to ask the Society of Arts to take steps to [get] a committee appointed. Of course, in suggest[ing] that modification, it must not be supposed that [he] could undertake, on behalf of the Council, that i[f it] were carried they would do so. It must come bef[ore] the Council in the regular way, and it would natur[ally] demand a good deal of consideration, because so[me] of the bodies applied to might not care [to] come in. He then put the amendment in [the] following form:—"That, in the opinion of t[his] meeting, it is desirable that provision sho[uld] be made for examination and inspection in [the] subjects of instruction undertaken by Technical [In]struction Committees, but not at present included [in] the schemes of the Science and Art Departme[nt,] the City and Guilds Institute of London, and [the] Society of Arts, and that with the object of giv[ing] effect to the same this Conference recommends th[at a] representative committee be appointed to draw u[p a] report and prepare recommendations upon the wh[ole] subject."

The amendment was carried by a considera[ble] majority, and was then put and carried as a subst[an]tive resolution.

The CHAIRMAN said under these circumstance[s it] was, of course, unnecessary to proceed with [the] second resolution.

A vote of thanks to the Chairman, moved by [Mr.] HODGSON, and seconded by Mr. SNAPE, conclu[ded] the proceedings.

Miscellaneous.

PATENTS FOR INVENTIONS.

The following historical notice of the Acts rela[ting] to patents is taken from a paper by Mr. E. H[.] Brewster, read before the Civil and Mechan[ical] Engineers' Society last year:—

he origin of the practice of granting patents to viduals, conferring upon them benefits, is lost in past, but it probably began by the Sovereign :ially rewarding one who had greatly distinguished self, either in battle or in council; and this grant, ıg acquiesced in by the people, it by degrees ame a recognised custom for rewarding merit. Edward Coke laid it down, that by ancient ımon law the king could grant to an inventor or ›orter of an invention a temporary monopoly, if in restraint of trade; and the first recorded case :onnection with monopolies supported this view. : case was that of Darcy *v.* Allin, and the date of 602. The earliest known patent for a monopoly t the time of Edward III., and the first Act of :liament for granting a monopoly that the writer :ognisant of is connected with the manufacture of s, and is the 17 Edward IV., c. 4. Many Acts of :liament granting monopolies have since been ssed, and continue to be passed; but the strictest ›ervision is now exercised by the authorities of h Houses of Parliament, and very strong case eed has to be made out by those in charge of the ls before they are allowed to pass.

The first general Act connected with patents was ıt of 18 Henry VI., c. 1 (1439), and is connected h their dates and their being properly recorded. e next Act of the kind was passed in the reign of :nry VIII., and was for the purpose of making id any patents that might be granted for the same ng that a prior patent already existed for (6 Henry II. c. 15).

The custom of granting Patents of Monopolies, e many other customs, was abused, and at last came intolerable, and so intolerable, that in the gn of James I., in the year 1623, the Statute ıown as the 21 James I. c. 3, or the "Statute of onopolies," became law, and it remains in force to e present day, with the exceptions of Section X., I., and XII., which were repealed, and their spirit ıbodied in the Patents, Designs, and Trade Marks ct of 1883 (46 & 47 Vic. c. 57). This Act of James abolished all patents for grants of monopolies, and :rmitted none to be made afterwards, excepting ose relating to the "working or making of new anufactures within the realm," and these grants ere to be the true and first inventor or inventors of anufactures only, and were to be for periods not eater than 14 years (see Section VI. of the Act); is upon this portion of the Statute that the law ›ncerning Patents for Inventions is founded.

Correspondence.

SUBMARINE CABLES.

Under the heading of "General Notes," in your *ournal* of June 28th, mention is made of a total length of all the cables laid up to the present time as being about 157,713 nautical miles, of which length 1,900 is stated to be insulated with india-rubber. This figure is not quite in accordance with facts, as to name only two companies who make use of india-rubber (Hooper's) core. The Great Northern Telegraph Company of Copenhagen and the Cuba Submarine Telegraph Company have at work at the present time about 4,000 miles of Hooper's india-rubber cable cores. Altogether, about 9,000 miles of submarine cable have been laid, containing Hooper's india-rubber core, the list commencing with the cable laid in 1867 between Ceylon and India. It may also be of interest to know that Hooper's india-rubber cable core, supplied in 1868 and later, is being re-sheathed for further use.

JNO. P. HOOPER.

Hooper's Telegraph and India-rubber Works, Limited,
31, Lombard-street, London, E.C.
July 1st, 1895.

Obituary.

JOHN HENRY GREENER.—Mr. Greener, who died at his home at Herne-hill on April 7th last, was said to be at the time of his death the oldest telegraphic engineer. He was born at Etherley, in the county of Durham, in 1829, and began his career in London in the construction of the Stockton and Darlington, the Liverpool and Manchester, and several other railways, ending with the Blackwall. It was in connection with the Blackwall Railway that he, in 1843, began to be engaged in electrical engineering in London. He was employed in the construction of telegraph lines in Norway and Denmark, as well as in this country, and later he took an important part in establishing telegraphic communication with India, *viâ* Asia Minor, Persia, and the Persian Gulf. Mr. Greener was elected a member of the Society of Arts in 1869.

Notes on Books.

A DICTIONARY OF ENGLISH AND FRENCH MILITARY TERMS. By Albert Barrère. London: Librairie Hachette. 1895.

This handy little volume of one hundred pages contains the alphabet of English-French words. The second part, to contain the French-English alphabet, is not yet published, but is promised for next month.

THE SCIENCE AND ART OF BREAD-MAKING. By William Jago. London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd. 1895.

Mr. Jago gave a course of Cantor lectures on "The Modern Developments of Bread-making," in

1889. The present work is a much larger and fuller treatise on the same subject. It deals with chemistry and fermentation in their applications to bread-making, including the chemical composition of wheat, flours, &c., and the biology of micro-organisms so far as it affects the subject; methods of testing wheats, flours and bread; the analysis of sugars, starch, cellulose, baking-powders, &c.; and the machinery and methods used in the manufacture of bread. The book, it will therefore be seen, is a very comprehensive one, and is meant to include all the information which is required by the scientific baker. Directions for the use of the microscope, polariscope, and the chemical balance are given, so that anybody possessed of the necessary elementary knowledge should find in Mr. Jago's book all the information he would require for the conduct of his business.

THE TELEPHONE SYSTEMS OF THE CONTINENT OF EUROPE. By A. R. Bennet. London: Longmans, Green, and Co. 1895.

The information given in this book is of special interest and value just now, when the telephone system of this country is admittedly on its trial, and when vigorous efforts are being made to change the whole basis on which it rests. Mr. Bennet writes avowedly as an opponent of the National Telephone Company, and the main object of his book is to show that the rates of the company are very greatly in excess of what they should be, and very much higher than those in other countries. Under these circumstances, his arguments and his statements must be taken as those of an advocate rather than as coming from an impartial judge, but the case, as he puts it, is undeniably a strong one. To show this it is merely necessary to say that the facilities, which in London cost £20, are given in numerous Continental localities for less than £5, and in some for less than £3, though the companies charging these low rates are able to pay reasonable dividends. That the London service is superior to that of any other city does not seem to have been urged by its defenders, and probably will not be.

Of the really more important point of efficiency Mr. Bennet does not say so much. This must, after all, be a matter of opinion, and anybody who has ever used the telephone service, say of London, New York, and Paris, can easily form an opinion for himself.

CHEMICAL TECHNOLOGY. Edited by C. E. Groves, F.R.S., and William Thorp, B.Sc. Vol. II. Lighting. London: J. and A. Churchill. 1895.

This is the second volume of the work, the first volume of which was published in 1889. It is based on the Chemical Technology of Ronalds, Richardson, and Watts, which itself was based on the German Technology of Dr. Knapp. The first volume [dealt] with "Fuel and its Applications," and was wr[itten] by Dr. Mills and Mr. F. J. Rowan. The se[cond] volume deals with "Lighting."

It is divided into five principal parts:—Fats [and] Oils, by W. Y. Dent; the Stearine Industry, b[y] McArthur; Candle Manufacture, by L. Field an[d] A. Field; the Petroleum Industry and Lamps [b]y Boverton Redwood and D. A. Louis. Of these [sub]jects, two have already been treated by the s[ame] authors in Cantor lectures, Mr. Leopold F[ield] having lectured on the Manufacture of Candles, [and] Mr. Boverton Redwood on Petroleum. Gas Li[ght]ing and Electric Lighting are excluded, and ar[e to] form the subject of a third volume, which [is] announced as nearly ready.

In the first section on Fats and Oils, Mr. D[ent] has only treated those intended for lighting, [the] oils and fats employed for lubrication, in painti[ng], and for other purposes being no doubt left for tr[eat]ment in some future volume. In spite of the en[or]mous development of other means of lighting, [the] manufacture of candles is still a large and import[ant] one. It is fully treated by the Messrs. Field, tho[ugh] it occupies only some 30 pages in a book of 400, [of] which 140 pages are devoted to petroleum, exclu[sive] of the amount devoted to lamps for burning pe[tro]leum and other oils. The account of petroleum [is] very complete. It gives the general history of [the] subject, describes the principal sources of petrole[um], the manner of obtaining it, and its general treatm[ent] and preparation. The section on lamps is mai[nly] taken up with the means for burning petroleum, [but] lamps for burning other oils are also fully describ[ed]. The section on miners' safety lamps describes all [the] best-known types. It includes Professor Clowe[s's] testing lamp, which is really a gas-lamp; but d[oes] not include lamps in which electricity is employed.

General Notes.

EAST LONDON TRADES EXHIBITION.—An [ex]hibition is being organised, under the hono[rary] presidency of H.R.H. the Prince of Wales, in c[on]nection with the People's Palace, and will be ope[ned] in March, 1896. The classification includes [the] usual section of an industrial exhibition; bu[t a] special feature of the exhibition is that sepa[rate] sections have been arranged for the work [of] individual craftsmen, students, and apprentices, [and] for collective exhibits from polytechnics and o[ther] similar institutions. A liberal schedule of prizes [has] been arranged in these sections. A special sectio[n is] also being arranged for women's work. The pr[izes] in this section are not yet announced. The c[om]mittee are also desirous of forming a loan exhibi[tion] of works of art.

Journal of the Society of Arts.

No. 2,225. Vol. XLIII.

FRIDAY, JULY 12, 1895.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CHAIRMANSHIP OF COUNCIL.

On Monday, 8th inst., at their first meeting fter the annual election, the Council elected Iajor-General Sir John Donnelly, K.C.B., s Chairman of Council for the ensuing ear. The various committees were also re-ppointed.

Proceedings of the Society.

CANTOR LECTURES.

IEANS FOR VERIFYING ANCIENT EMBROIDERIES AND LACES.

By Alan S. Cole.

Lecture I.—Delivered February 11, 1895.

Allow me to say, as a preface to these ectures upon "Means for Verifying Ancient Embroideries and Laces," that having no riginal discoveries to place before you, I an offer you only a few suggestions which ave occurred to me, after looking at various iings, comparing them together, and dipping ito different books. My researches have not een as thorough as I could wish, and the ompilation of the lectures has, I am afraid, een too hasty.

The ancient embroideries—or rather, in the rst place, those indications of them which e will consider—are to be ascribed chiefly to gyptians and Assyrians, Babylonians, and ther kindred Oriental people, who, according) history, were brought into frequent inter-ourse with one another during the two or iree thousand years B.C. Later on, their escendants and successors, inheriting ancient aditions in the pursuit of ornamental arts, ere similarly brought into contact with the arlier historic nations of Europe, such as the reeks and the Romans. Various epochs of the embroidery art being thus linked together, a sort of general review of its ups and downs, its developments and modifications may be attempted. And such a review I am going to attempt in the first and second of this course of lectures. The third, and last lecture, I reserve for laces. These do not involve so extensive a survey as embroideries. For laces are virtually European in their origin; and the epochs of their growth in many varieties fall within a comparatively recent and short period, say from the 16th to 18th century. The 19th century, with a preponderance of machine-made laces (reproductions, to some extent, of the older and much more elaborate hand-made laces) is a period that I shall not be able to deal with in the present course of Cantor lectures.

The means for verifying or identifying the materials and methods used in the making of ancient embroideries from, say 3,000 to 1,000 B.C. are not very precise. Many suggestions that various methods of textile ornamentation were then in use may be easily gleaned from the folio volumes of Champollion and Lepsius which contain admirable illustrations of Egyptian sculpture and painting. For corresponding indications of Assyrian textile ornamentation there are the splendid Assyrian sculptures in the British Museum, as well as illustrations in the folio publications of the late Sir Henry Layard and Monsieur Place to turn to. From such sources we see that ornamental textiles for costume, for other articles like cushion covers, hangings, horse trappings, and the like were extensively used. Many of them were woven: on some the ornament was dyed or stamped, on to others it was stitched and embroidered, whilst into others (and these, possibly, by far the more numerous), it was darned or in-worked with a needle. No actual remains of these very early things have been handed down to us. The references to them in records or writings give us very small clue to the peculiar technical ways in which they were produced; we can at best only guess and conjecture what these were; but in this respect we have within the last few years become possessed of collateral evidence, which helps us to guess rather more correctly, I think, than formerly.

Now, from about 1,000 B.C., as concerns Egypt, and from about 400 to 350 B.C., as regards Greece, we have, in public collections, specimens of actual embroideries made about the times, of Shishak, king of Egypt, who took all the towns of Judah, and pillaged the temple

of Jerusalem: and of Alexander the Great, whose exploits and conquests were of much greater proportion and extent. Neither Athens nor Rome existed at the earlier of these two dates; at the later of them, Rome was just commencing to make herself felt, and Athens was close on to the period of her gradual decline. From about 100 B.C., and up to 700 or 800 A.D., we have a vast number of pieces of actual textile ornamentation from many disused cemeteries in Egypt, and these show us phases of such work as was done towards the end of the Ptolemaic or Greek domination in Egypt, the best period of imperial Roman times, the succeeding centuries of the later Roman empire, and of the Byzantine court, and the first century or two of the Mohammedan invasion. Roughly speaking, then, from 1,000 B.C. onwards, we have to-hand a series of specimens, from the consideration of which we make deductions as to the probable technical character of works indicated in more ancient sculptures and paintings of textile ornamentation. Within the period of the 8th and 9th century after Christ I propose to fix the limit to my remarks. Embroideries made from after the time of Charlemagne, during the Crusades, the so-called Middle Ages, the Renaissance, and subsequently, we must look upon as relatively modern and outside the scope of our present consideration.

Style or character of the forms of ornament on textiles, which are indicated in paintings and sculptures, is, I think, important, as somewhat of a guide to the probable manner in which such ornament may have been either woven, stamped in colours, or worked with a needle. But before developing suggestions on these lines, I must briefly indicate what are usually held to be embroideries.

Embroideries are distinct from weavings with a shuttle in a loom. Weaving produces a stuff, and ornamental effect is not an essential element in the production of a weaving. Embroidery, however, adorns a woven stuff, and cannot be dissociated from ornamental effect. Some stuff or material is therefore a first necessity to an embroiderer. There are many ways by which he may do his work. He may darn or run stitches into a stuff without much changing its flexible quality or the general flatness of its surface. By other stitches, such as long or short stitches, chain and satin stitches, laying and couching threads, he may load one surface only of a stuff, and to that extent alter its flatness. Again, he may cut out forms from other stuffs and sew them on to the foundation stuff, and thus affect th flexibility and flatness of it. But beside these ways of embroidering a stuff, there ar other needlework methods often classifie with embroidery. And the principal one o these is patching, or sewing together pieces cu out from different stuffs to fit one another Patchwork when well made should have a fla surface and be uniform in its texture. Othe branches of embroidery known as drawn threa and cut work bring us closely to needle-mad laces, but of these I shall speak later. For th present let us keep ourselves to darning o passing threads into stuffs, to stitching thread on to stuffs and to patching bits of stuff to gether. Here then are three distinctive sort of embroidery, two of which (the first an third) do not greatly affect either flexibility o material or flatness of its surface: whilst th second, of the three, results, by comparison, i inequalities upon the surface, thereby loadin or stiffening the foundation material.

The antiquity of these three sorts of embroi dery is unquestionable, since traces of thei use are abundant amongst a people whos primitive culture is presumably analogous t the ancestors of ancient Egyptians, Assyrians Babylonians, Persians, and Greeks. Wit the means at their disposal, these latter his toric and civilised people did certain kinds o embroidery in a way far in advance of anythin nearly corresponding to them that moder embroiderers in civilised countries attempt Certainly the regard or respect for the suitabl use of materials seems to have been more in tuitively felt and observed by earlier than it i by modern embroiderers; and this strengthen a supposition that methods of producin textile ornamentation by needlework, whic would not greatly change the texture of a stu to which it was applied, were for some tim subject to little variation. Just as the fe needlework methods seem to have endured fo long periods, so, too, do style and characte of highly conventionalised ornamental designs

Now, besides the respect for material, an the prolonged adherence to similar conven tional ornaments, climate, I think, had som influence in assisting lengthened survivals o methods of work and use of certain sorts o materials by ancient historical embroiderer In very warm climates one would not expect t find stout textile materials loaded with heav embroideries. In cooler climates one would no look for indigenous art in the embroidery of deli cate textiles like muslins, which would not b suited for use under such conditions. Again

laborated work, necessitating the use of delicate threads and fine needles would not be looked for amongst nations who, according to historical evidence, possessed neither the one nor the other. Whatever may have been taking place in the far East, as in China, in the use of fine silky threads and delicate implements 2,000 or 3,000 years B.C., it is fairly certain that silk and fine needles were practically unknown to Egyptians of such a time. Neither were silks and fine needles known to the Assyrians, of whose gorgeous textile ornaments we have so many suggestions in the sculptures at the British Museum, dating from the 9th to the 7th centuries B.C. Let us therefore dismiss from our mind's eye any pictures we may have formed of glistening and delicate silken embroideries having been made by ancient Egyptians, Assyrians, and even Greeks. If we agree to do this, we shall, I think, simplify the aspect of the matter we are considering.

By excluding silk, which is so freely used in later embroideries, we restrict ourselves to stouter textiles, made of flax, hemp, wool, and cotton. In Leviticus (about 1490 B.C.) reference is frequent to garments of linen and wool, and I think reflects the use of linen and wool, in Egypt, on the one hand, and in the Mespotamian country on the other. Now, as regards cotton, its employment in Egypt dates from a later time than that we are first going to deal with. Pliny certainly speaks of cotton being grown in his day in Egypt, and alludes to its employment by priests and by the Government for the use of temples. But Pliny is comparatively modern. He tells us that the invention of cotton-weaving in Assyria is attributed to that legendary queen, Semiramis, which is not very valuable as evidence. Herodotus, fully five centuries earlier than Pliny, refers to something which some translators have accepted as cotton; but other specialists have more closely examined this technical point, and have shown that, whatever Herodotus was referring to, it was not the cotton fibre capable of being spun and woven, as was the Indian cotton.

In Yates's "Textrinum Antiquorum," a most valuable work, which apparently sums up almost all the ancient knowledge or information available in regard to textiles, a map is given, showing the natural distribution of raw textile materials in the ancient world. A copy of this map is now thrown on the screen. First, let me remark that the gradual use for manufacture by people of raw materials not grown in or common to their particular countries, arose, no doubt, when, through trading operations, foreign raw materials came to be largely dealt with. Extensive trading in raw textiles was not, I imagine, carried on by the Egyptians and Assyrians at the time we propose to talk of them. The map before us should be tinted with colours; if it were, we should see that a yellow tint in the far right indicates the silk-growing region—or rather the outskirts of the vast region unknown to the ancients—the inhabitants of which clothed themselves in silk. The tint (red) which stretches across the width of the map and includes Assyria and a great part of Southern and Central Europe, indicates countries in which sheeps', camels', and goats' wool and hair formed the staple textile material. The tint (green) indicates where flax was cultivated in lowlands bordering on rivers. The tint (brown) indicates the cultivation of coarser textile material such as hemp, which however, has been commonly used chiefly for sails and coarse cloths. The tint (blue) indicates cotton-growing districts. From this map then it appears that in Egypt, Assyria, and Greece the prevailing textiles were woollen and linen ones. Egypt's pre-eminence as a manufacturing country of fine linens is practically co-incident with the earliest known periods of her history. The late Sir Henry Layard was of opinion that the Assyrians made their costumes of linens and wools. Gold threads were also employed by the Assyrians and other Orientals for purely ornamental purposes.

Now I think it is interesting to find, as we certainly do, that the most ancient ornamental textiles in existence are made of linen and wool. Some of them preserved in the Hermitage at St. Petersburg are from Græco-Scythic settlements along the north-west coast of the Black Sea, and date from the 4th or 5th century B.C. or from 2,000 to 200 years subsequently to the dates of those indications of Egyptian and Assyrian embroideries we are to examine.

Notwithstanding this interval in time, we may perhaps regard the use of linen and wool in the make of the Græco-Scythic pieces, as reflecting earlier and similar use by other wool and flax-growing people, who were in frequent contact and communication with each other, such as were Egyptians, Assyrians, Persians, and Greeks, successively. Identical in make to the Græco-Scythic embroideries, and so displaying these materials and the particular process in using them at a later date, are a large number

of Egypto-Greek and Roman specimens of the 1st century B.C. to about the 9th century A.D. And the predominant method of embroidery in these latter specimens is a darning or in-working of coloured woollen threads into portions of linen garments and cloths. This darning or in-working was done with a bone or wooden needle, and is quite different from shuttle weaving.

In my Cantor lectures upon Egyptian tapestry, I endeavoured to explain how this darning or in-weaving method of needlework, so well suited to the adornment of costumes and small textile articles, came by degrees to be developed into a process involving the use of large frames containing only a web c warp threads for the production of grea tapestries. It thus lost its character as a embroidery or needlework method, and becam a weaving process. I need not go over th ground again. I will merely repeat, here, tha ordinary shuttle weaving, such as the ancient practised, is a process which was universa and of all known time. The most intricat ornaments woven with shuttles were in th nature of stripes, checks, and other straigh line patterns, and spots dotted at regular in tervals throughout a stuff. All these may b wrought by simple changes in the grouping o coloured warp threads, and throwing in be

Fig. 1.

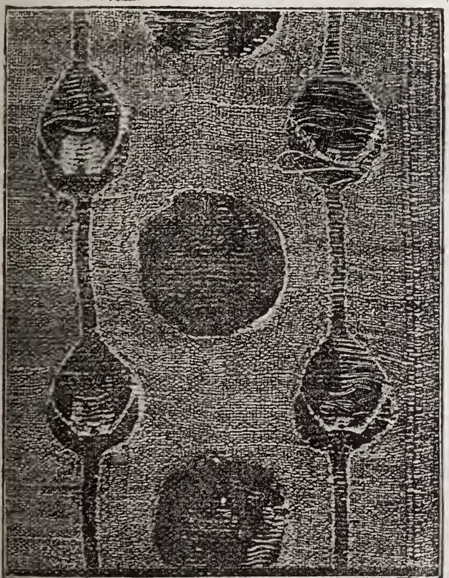
Egyptian King in Striped Dress of Coloured Shuttle Weaving.
From a wall-painting in the Ramesseum. About 1400 B.C.

tween and across them shuttle threads of other colours. Here, for instance, is an illustration of Egyptian weavers, at least 2,000 years B.C., engaged in making such work. In this case the ornament of the textile in the weaving loom is a check or chess-board pattern. Another slide displays a well-known type of an Egyptian king overcoming his enemies. His dress, and the cloth on his horse, are striped (Fig. 1). The dress stripes are blue and yellow, those on the horse-cloth are blue, yellow, red, and green. I take it that these textiles were of ordinary shuttle weaving. The original painting from which this diagram is taken is on a wall in the Ramesseum, and dates from at least 1400 B.C.

When, however, people first sought to infuse ornaments having curved forms into stuffs which had been produced by shuttle weaving they either stamped or embroidered them Such ornament was not woven with a shuttle for the mechanical contrivances for intricate pattern weaving in a shuttle loom are, appar- ently, of comparatively modern invention, ever amongst such renowned weavers as th Chinese, Persians, and Indians. By compara- tively modern I mean not earlier than 200 o 300 years B.C. Apart from stamping, wha then was the process which was the more likely to have been used much earlier for in- tricate ornament? It was, I think, the darn- ing, or inwrought needle process.

Here is part of a linen tunic, possibly of the th or 5th century A.D., made by some Egypto-Roman (Fig. 2). The darker devices were darned, or inwrought, with a needle and coloured worsteds, into openings purposely left in the linen as it was manufactured in the shuttle loom. Some of the worsted threads have disappeared, but the under linen threads over which they were darned still remain. It will be noticed that the darning-in of the wools completes the entire fabric, and does not substantially change the flexibility and flatness of its texture. It may be readily gathered that any sorts of ornament could be darned in this way, which, therefore, I suggest, exemplifies a better regard or respect for materials than would be the case had the ornamentation been stitched, and thus loaded, on to the linen.

Fig. 2.



Linen, with Coloured Worsteds Darned or Inwrought with a Needle.
Egypto-Roman. About 4th or 5th century A.D.

The next diagram is from a similarly-darned and inwrought fabric. The pattern consists of repeated birds—ducks (Fig. 3). This piece is of Græco-Scythic work, of the 4th or 5th century B.C., so that it is some 800 years earlier than the previous piece, and is therefore an evidence of the prevalence at that time of the same method of ornamented needlework. It is most probable that Egyptian specimens of embroidery—described with much minuteness by Herodotus in the 5th century B.C., but produced some 150 years before he lived—were made according to this darning method. These specimens—and Herodotus evidently saw and examined them—were corselets, sent as presents to the Greeks by Amasis, king of the Egyptians. Of one, Herodotus writes that it was of linen, with "many figures of animals inwrought, and adorned with gold and tree wool." The character of these corselets is considered by various authorities, Birch and Rawlinson, to be indicated in such corselets or breast coverings as are seen in the paintings of the wall of the tomb of one of the Rameses at Thebes Here is a photograph of a series of such corselets overlapping each other; the outer one exhibits the ornamentation—a pair of winged animals—above two lions. How much or which of the parts were adorned with gold cannot now be defined. The painting itself dates from 1,500 B.C.; and accepting the statement that it represents such corselets as were described by Herodotus 1,000 years later, we then have some ground for holding that the darning or in-wrought needlework with coloured threads into linen was practised 1,500 years B.C.

And here allow me to make a slight digression with regard to the use of golden threads in early embroideries. From the book of Exodus (chapter xxviii.) we learn that the ephod, the girdle, and breast plate (a sort of corselet), provided for Aaron, were made in needlework of blue, purple, scarlet, and gold threads. And in chapter xxxix. we find that the people charged to carry out the needlework "did beat gold into thin plates and cut it into wires (strips, probably) to work it into the blue and the purple and in the scarlet, and in the fine linen with cunning work." We can almost see the glisten of the gold wires or strips enhancing the effect of the deader looking coloured worsted work. This record of embroidery, and of gold in embroidery, dates from about 1490 B.C. and after the Israelites had been in Egypt. Their method of work probably resembled that of the Egyptians, and if so, then it is likely that it was of the darning, inwrought character. With the descriptions of Herodotus at one end, and those from Exodus at the other end, of a period from 500 to 1500 B.C., it is not, perhaps, too bold an assumption to hold that the intermediate Assyrians, intimately associated with Egyptians and Hebrews, and renowned for ornamental splendour in their robes of State, were producers of technically similar darning and inwrought work of linen, coloured wools, and gold. It is rather remarkable, however,

that amongst the Græco-Scythic fragments, contemporary with Herodotus, we should find no inwrought gold thread work. The only thing approaching the use of gold in the Græco-Scythic textiles are pieces of head-dresses, or sorts of diadems, of which I have a photograph. The leaves here shown are of thin plates of gold stitched on to the woollen material or foundation of the head-dress. That gold, however, was otherwise also used by the Greeks is evident, for in both the Iliad and the Odyssey there are descriptions of needlework with gold. Greek writers from the time of Alexander (4th centu[ry] B.C.), as well as Roman, well on into t[he] Imperial Roman period, give innumerab[le] references to the use of "cloths of gold." Of Asiatic historic nations "none," accordin[g] to Yates, "was more remarkable than th[e] early Persians for the display of textures [of] gold."

I now pass on to the series of diagram[s] illustrating indications of ornament on textil[es] to be found in Egyptian paintings, &c., an[d] with the help of the preliminary remarks I hav[e] made I hope to be able to offer some reason-able suggestions upon the different ways in which such ornament was wrought on actual stuffs.

FIG. 3.

FRAGMENT OF LINEN, WITH DUCKS IN COLOURED WORSTEDS DARNED OR INWROUGHT WITH A NEEDLE.
Græco-Sythic. About 4th or 5th century B.C.

In the diagram on the sreen we have four figures said to represent an Asiatic family brought into Egypt. To some extent this group might be regarded as similar to what might have been depicted had it been a question say of Joseph's brethren coming down into Egypt to buy corn. This is from a painting at Beni Hassan and dates from about 2100 B.C. The dress of the second figure to the right is powdered with spots—a sort of simple ornamentation not unlikely to have been produced in ordinary shuttle weaving. The ornament on the other dresses was probably either stamped on to the linen, or else it was darned or inwrought with a needle.

From the same series of paintings is this figure with an ibex (Fig. 4). And although straight line ornament is shown on the dress and might therefore be said to have been of shuttle weaving, its disposition or arrangement is somewhat irregular, and leads me to think it more likely to have been of darning or inwrought needlework.

The next diagram on the screen is from a painting about 1540 B.C. on the wall of a tomb at Thebes. The personage in the ornamental dress

an attendant upon an Ethiopian Prince Hui, ho paid tribute to a king of Egypt. There are /o kinds of powdered spot ornament on the tendant's dress. On the white portions of the ess are red and blue spots, or rosettes, e darker portions of the drapery are blue, ith red rosettes. As before noticed, whilst ite simple spots could be woven with a uttle into a dress, it is doubtful whether these ightly more intricate rosettes devices would ave been so produced. The commoner way rendering them would, I think, have been y darning or inwrought needlework. On the her hand, they may have been stamped in lours. This, in regard to the red rosettes the blue stuff, would have implied the nployment of mordants as well as dyes, with oth of which, however, the Egyptians appear have been acquainted from early times.

FIG. 4.

IGURE WEARING A DRESS, PROBABLY OF LINEN, WITH PATTERN IN COLOURED WORSTEDS DARNED OR INWROUGHT WITH A NEEDLE.

From a wall-painting at Beni Hassan. About 2100 B.C.

The two figures next displayed on the creen are Syrians clad in loose dresses, omewhat rudely ornamented. They occur the paintings on a wall in the temple of eti I., about 1400 B.C. On the dress of e left-hand figure, the odd-shaped deices, derived apparently from the markings f a leopard skin, were probably stamped in olours. The simple outline ornament of the ther figure's costume might suggest simple titches on to it, were it not that the inner side f the dress is seen to be the same as the other, whence one might conclude that the stuff was one of those of divers "colours of needlework on both sides" mentioned in the Bible, in which the needlework would have been probably of darning, though a satin stitch might have been used, and have been equally effective "on both sides."

The figure now shown is that of an Egyptian princess about 1500 B.C. She holds a sistrum with lotus flowers, and an ivy garland hanging from it. Her dress is decorated with simple and dainty ornament, such as could have been done on to it with short stitches.

Hathor and King Meneptha I. appear in this next diagram on the screen, the original of which dates from 1325 B.C. Hathor's dress is covered with ornament, consisting, first, of a diaper of hexagons, scarcely perceptible: for within the hexagons are repetitions of symbols producing the effect of horizontal arrangements across the dress. These may have been either stamped or inwrought by the darning method. If the subsidiary hexagonal pattern stood alone by itself, then it might have been of shuttle weaving; the other devices, however, would not have been so produced.

Dating from 700 B.C., and taken from an Ethiopian temple at Naga, in Upper Nubia, is this figure robed in a costume covered with small crosses. The arrangement of these is not very regular, hence I conclude that they were not of shuttle weaving. They are more likely to have been darned in short stitches in to the dress. From the temple at Kalabsheh, in Nubia, and about 110 B.C., I have taken this figure of Osiris. His cloak is covered with a trellis or diaper pattern, which was, most probably, of darning or inwrought needlework, and this conjecture is supported by the fact that specimens, rather later in date, of kindred ornament wrought by this method have been found in Egypto-Greek cemeteries.

Of ornamented textiles for cushion covers, I have an illustration from a painting at Thebes dating about 1250 B.C. Those on the two upper chairs are white with powderings of red blossoms—those on the two lower ones are respectively of red and blue grounds with yellow discs. All of them may have had the ornament stamped on them—but if not stamped then the two upper chair covers would have been of inwrought needlework, and the two lower ones probably of shuttle weaving.

My next slide gives a specimen of the thread and bead work so often found upon mummies. It is not however a needlework in the sense of

embroidery on a textile—although the little flattened beads were possibly passed on to the threads by means of a needle of some sort: on the other hand they may have been quite easily slipped on the threads without a needle. In the pieces before us we see the well-known Egyptian beetle or scarabæus.

The foregoing series fairly illustrates prevailing types of ornamentation, wrought by different methods on and into the surfaces of textiles, during a period B.C. of over 2,000 years, in Egypt. That the materials used were almost entirely linen and wool, I have little doubt. It seems doubtful whether the earlier Egyptians made much use of gold thread. Yates gives no instance of their having done so. The only ones that occur to me are the corselets already mentioned, and quoted from Herodotus. These, however, are of a comparatively late period for Egypt, namely century or two before the commencement the Ptolemaic dynasty. Egypt had then b continuously, and, I think, strongly influen by Assyrians, with whom, as with ot Orientals, the use of gold thread was famili Hence the inwrought gold threads of corselets, and, indeed, some of the charac of the design for the ornament on the cor lets, may be held to indicate, in some degr Assyrian usage and feeling. Certainly t designs of animal forms on the corselet p sent a difference in style from much of t Egyptian needlework ornament just reviewe

Such difference is still more marked wh we look at indications of ornament on Assyri stuffs. The first of these, in point of date, that of the fine robes worn by King Asshurn irpal and his attendants, sculptured upon gre

FIG. 5.

KING ASSHURNAZIRPAL AND ATTENDANTS IN EMBROIDERED ROBES.
From the Nimroud Bas-reliefs. 884 B.C.

slabs taken from the palace of Nimroud, and dating from about 884 B.C. (Fig. 5). Both robes are fringed, and the ornament on each is largely composed of human and superhuman beings, of elaborate sacred tree emblems, and of radiating palm devices, from which it is usually thought that the Greeks modified their long famed honeysuckle ornament, or anthemion. The borders only to the dress of the king's attendant are decorated with similar figures and emblems. The style of this elaborate ornamentation will be better seen in the enlarged diagram of the shoulder and upper part of the king's dress (Fig. 6). By no shuttle and loom weaving, so far as we know of it at that date, could this ornamentation, involving complex curves and intricate forms, have been produced. It was no doubt rich in colour, and n the glisten of gold threads. Sir Henry Layard suggested that it may have been li the "prey of divers colours of needlework both sides, meet for the neck of them th take the spoil," for such a potentate, indee as was Asshurnazirpal. Needlework on bo sides could not have been an embroidery long and short feather stitches, nor of cha stitches, nor of *appliqué* work, each of whi makes a display on one side only of t material so worked upon. It could hard have been of patchwork, which may ma an equally effective display on both side for the details are too elaborate for su work. We shall presently see very beauti patchwork which was made in Egypt a centu earlier than Asshurnazirpal, but with differe materials from the linen, coloured wools, a gold thread, which I think must have be used in this Assyrian embroidery.

The only method of using these materials to ke an effect on both sides must, I think, ve been a darning method. Let me again y that, with the ancients, the ornamental ssibilities of materials were strictly observed. is only in much later phases of art that the aving for effect supervenes and breaks rough the apparent restraint of well developed rly art. With this to weigh with us, as well the apparent prevalence of the darning or in-ought method, together with the notion of the broidery on both sides, I conclude that that thod is the more likely and suitable one, by ich the Babylonian embroiderers at the court of King Asshurnazirpal wrought his robe of State. Babylonians, as is well known, were for centuries notable for their cunning embroidery, and supplied all parts of the ancient world with it down to the times of the Romans. Achan, in the 15th century B.C. confesses to Joshua that he coveted and took from amongst the spoils of his Syrian foes "a goodly Babylonish garment"—a well embroidered one no doubt, and Ezekiel 900 years later tells us of the "blue cloths and broidered work" in which the merchants of Tyre traded with those of Asshur or Assyria.

Before dealing with the remainder of my

Fig. 6.

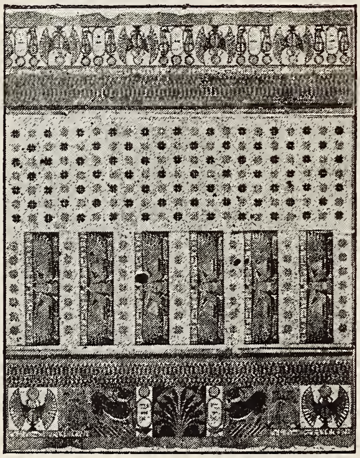
Enlargement of Embroidery upon the Body of King Asshurnazirpal's Robe.

ssyrian diagrams, I wish to refer to the tchwork method as practised in Egypt out 1000 years B.C., somewhere about the puted time of Homer. An actual specien of such work has been fully described by r. Villiers Stuart, and from his work I have ntured to borrow the two illustrations of this ecimen on the screen. The first one disays an Egyptian boat conveying a canopied er, which contains the remains of a defunct gyptian queen. The size of the canopy d the proportions of its ornamentation ay be inferred from its relation to the size of the persons on the boat. The lower side—which we see before us—of the canopy is of a large check pattern. Above it is a border of squares, containing different emblems.

We get, on a larger scale, the top and other border of the canopy in the next slide (Fig. 7). Half of the main part of the top is powdered with blossoms; the other half has a series of oblong spaces filled in with vultures. The upper border has repeated scarab cartouches, with inscriptions, and discs and serpents. The lower border, which was also figured on the boat scene, contains a central radiating lotus

device, a goat on each side of it, pairs of conventionalised ducks, and scarabs. All this ornamental needlework, now in the Museum at Cairo, is of gazelle hide, cut out into the different forms described, and patched together with coloured threads. The colours of the several pieces of hide are bright pink, deep golden yellow, pale primrose, bluish green, and pale blue. Possibly of similar material and workmanship was the border to the pedestal upon which this figure from the great temple at Philæ is seated. This, however, is considerably later than the funeral canopy, as it dates from about 200 B.C. The winged creatures are white, outlined in red, and the ground of their panels is alternately blue and green. The seat is covered with a scale

Fig. 7.



Egyptian Coloured Kid Patchwork.
About 950 B.C.

pattern of green and blue and white, each scale outlined in red. The same sort of ornament appears upon the body of the figure, and may have been of patchwork, though probably in coloured textiles. I think we may assume that patchwork was a method of decorative needlework, well-known and pursued with artistic finish at least from about 1,000 years B.C. in Egypt; and if there, then also to some extent in countries like Assyria, which were in touch with Egypt.

And now, returning to Assyria, we may derive suggestions of patchwork from the character of the simple ornament upon such a figure as this of Sargon the King (Fig. 8). The original is of coloured enamelled brickwork from Khorsabad. It is some 160 years later than the Nimroud sculptures of Asshurnazi[...]. The ornament consists of what I take t[...] feather-shape devices arranged along [...] borders of the king's dress. The colou[...] the dress is blue, but the feather devices [...] yellow. These, I think, were probably patc[...] into the blue ground.

Fig. 8.

King Sargon. The Ornament on the Dr[...] is possibly of Patchwork.

From coloured enamelled brickwork of Khorsabad. Assyri[...] 719 B.C.

The same may be said of the costume [...] this winged figure, also from Khorsaba[...] This winged figure, in the original enamell[...] brickwork, precedes King Sargon. Behi[...] him, and at some distance from him, com[...] his Vizir. His dress consists of a robe, strip[...] upon the upper part of it, and bordered wi[...] deep check pattern; both of these seem to n[...] to have been of shuttle weaving, rather th[...] of any sort of embroidery.

There are, amongst the Assyrian sculpture[...] one or two instances of patterns generally co[...] sidered to represent ornamental stuffs, whic[...] were used as rugs. Here, on the screen, is o[...] of them. It was taken from the ruins of t[...] palace at Kouyunjik (705 B.C.). The bord[...] is composed, first, of a series of lotus flowe[...] and buds, then of a series of daisy blossom[...] next of a series of radiating palm devices, an[...] then of a series of daisy blossoms. The orna[...] ment of the main portion, or field of the ru[...]

of intermingling six-limbed stars, formed by intersections of repeated circles. This amentation may, perhaps, have been made patchwork; but it is complex and difficult reproduction in that method. It was not shuttle weaving, therefore it must have been some sort of embroidery on to or into a ndation stuff. That it was a rug or a or-covering suggests a textile with a cut-e surface perhaps. But this special kind of nufacture is, I am led to conclude, of much er date than the times of either the Assyrians the early Persian dynasty. The history of t-pile carpet and rug making, having such a antity of intricate ornamentation as that of s diagram, is involved with that of velvets d plushes, the existence of which, I fancy, not to be traced until Byzantine times. rtainly the period of finest cut-pile Persian d Mohammedan carpets is that of the 16th ntury, A.D. If, then, the surface of this syrian rug were flat in texture, with no sort pile, the ornament would have been made the inwrought darning method, just as are any Eastern rugs of the present day even. however, it had some sort of raised or aggy surface, then I think it would have en a linen or hempen stuff worked with loops tufts of wool; and the oldest known exam-es of such tufted-surface needlework are be found amongst Egypto-Roman textiles ting from about the second century A.D. ere is a photograph of such work. All the nament we see is of bold needlework of ick worsteds. These are darned into the undation material, and the threads of each itch are regulated to form close-lying loops tufts, so that the whole of the outer surface the needlework is soft and yielding. I think at there is no great improbability in the otion that this looped-needlework method was nown some centuries earlier than 100 A.D., nd to the Assyrians, amongst other people.

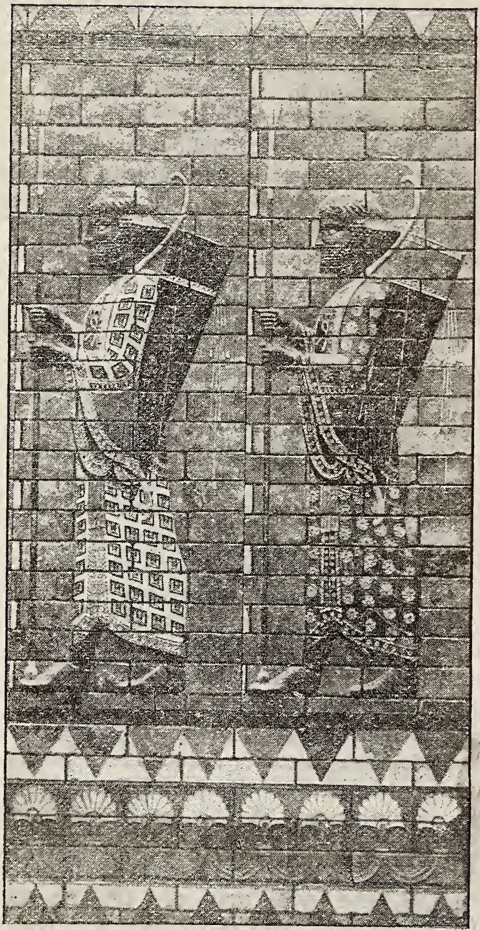
There is little connection between it and the inged borders which were so commonly used r Assyrian costumes and cloths. And with e question of fringes I shall not venture to ouble you now beyond showing a diagram of ostumes with fringes worn by humbler persons an the kings and ministers whose fringed nbroideries must be accepted as evidence of e highest class to which the art of the As-rian needle-worker then attained. The in-ividuals here represented are bearing tribute om Jehu to Shalmanazar (880 B.C.), and are om the sculptured pedestal of that date in e British Museum.

It will have struck you that the simple ornamentation of the robes from Khorsabad, in which I suggested the use of patchwork, was different in style from that of the Nimroud sculptures. The Khorsabad enamelled bricks date from 719 B.C. and the Nimroud sculptures from 884 B.C. From this circumstance alone we might imagine that as time went on Assyrian ornamentation became simpler. This however was not the case. For the Assyrian sculptures of 668 B.C., from Kouyunjik, supply instances of the return to, or perpetuation of, a style of ornament in textiles similar to that of over two centuries previously. Here on the screen is King Asshurbanipal out lion hunting. His dress is powdered over with the traditional daisy blossom embroidered in the inwrought darning method. It is fringed, and his saddle cloth is edged with pointed tassels. The harness is embroidered or enriched with daisies perhaps of thin beaten gold.

We are now getting near the time when the Assyrian monarchy was overthrown by the Persians. According to Sir Henry Layard, "the Persians were probably a rude people, possessing neither a literature nor arts of their own, but deriving what they had from their civilised neighbours." They employed the handicraftsmen and artists of the conquered Assyrians and Babylonians; and what can be called Persian art of the period, say of Darius I. (about 520 B.C.), is a direct descendant of Assyrian and Babylonian art. I have been unable to find many traces of early Persian embroidery. The best specimen is from the enamelled brickwork discovered by Monsieur and Madame Dieulafoy, and identified as part of the palace of Darius at Susa. The original brickwork is now at the Louvre at Paris, but an excellent *facsimile* of it has been acquired by the South Kensington Museum, and from that, the two figures now shown have been taken (Fig. 9). They are, as you see, soldiers armed with bows, carrying big quivers on their backs. The shape of the costume of each is the same, but the ornamentation differs slightly. In both dresses it consists of an orderly repetition or powdering of similar details. On one of the dresses these details are circular blossoms, with white, green, and blue petals, a reminiscence, but not a precise copy of the Assyrian daisy device; in the other dress, the details consist of small brown squares, each containing a triple tower fortress, picked out in white, yellow, and green. The narrower borders to the sleeves and dresses have repeated discs

and alternations of the lotus flower and its bud, picked out in whites and greens, &c. On the brown, large arrow quivers, fastened to the backs of the archers, are scattered in regular series, dark and light grey green, bean-shaped devices. I think that the embroidery of the dresses was of inwrought

Fig. 9.



Coloured Enamelled Brickwork, with Archers in relief. The Ornament on their Linen Dresses is possibly of Coloured Worsteds Darned or Inwrought into the Linen.

From Palace of Darius at Susa. About 520 B.C.

darning, and the materials probably were woollen. The colours of the original enamelled brickwork are fresh. The whole of the surface, from which the moulded figures stand in relief, is of turquoise blue. The dress of the first archer with the squares of embroidery is white, with yellow sleeves, whilst that of his fellow with the circular embroideries is yellow, with d brown sleeves. Both have brown complexio their tightly curled hair and beards are bla and the bindings round their heads are gre

I have thus endeavoured to present to y some ideas of the ways in which Egypti and Assyrian embroideries may have be wrought, suggesting that the more frequen used methods were those of in-wrought darning needlework and of patchwork. T materials were linens and wools, enrich sometimes with gold threads. The differen between the styles of Egyptian and Assyri ornament in its relation to textiles has al been touched upon.

Next Monday I propose to treat the indic tions of Greek embroideries in a simil manner, deducing, from the new ornamen features we shall find in them, addition methods of needlework. From these we sh pass on to Roman, Byzantine, and Saracen specimens, from which we shall obtain a furth insight into the use of all the methods pr viously noticed, as well as evidences of vari tions of ornament due to the influence lingering traditions and remains of earlier a more formal ornament, upon later and mix races of people.

Correspondence.

CONFERENCE ON TECHNICAL EDUCATION.

I find, upon reading through your report of th Technical Conference, held at the Society of Ar on 20th June, that I inadvertently stated that th Board of Agriculture undertook the examination o the classes devoted to these subjects in the county o Essex. This was an error, which Mr. C. William subsequently corrected, for they only came to inspec and report upon the system of teaching, withou holding any examination at the end of the cours Throughout the Conference, "examination an inspection" were bracketed by almost every speake and they appeared together in all the resolutions. ought, therefore, to have drawn a distinction, an said that the Board of Agriculture undertakes inspec tion, whilst Professors Liveing, Howes, and Dr Masters have examined our normal students for th teaching certificate in Essex.

Kindly permit me to make this correction, and t thank Mr. Williams for pointing it out.

John Spiller,
Member of the Essex Technical Instruction Committee.

London, July 10.

Journal of the Society of Arts.

No. 2,226. Vol. XLIII.

FRIDAY, JULY 19, 1895.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

TEN-VOLUME INDEX TO "JOURNAL."

The new Index to the *Journal of the Society f Arts*, for volumes xxxi. to xl. (1882-1892), s now ready, and can be obtained by members n application to the Secretary, John-street, delphi.

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Proceedings of the Society.

CANTOR LECTURES.

IEANS FOR VERIFYING ANCIENT EMBROIDERIES AND LACES.

By Alan S. Cole.

Lecture II.—Delivered February 18, 1895.

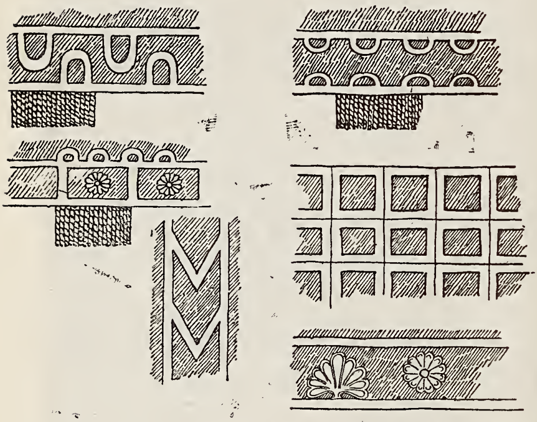
You will, I think, remember that in my rst lecture I endeavoured to explain how it as that the methods employed by early gyptians and Assyrians for their ornamental eedlework seemed to consist, in the main, f two: namely, an inwrought, or darning ethod, and a patchwork method. I tried to how further, by instances of ornamental esigns on ancient textiles, that these two ethods were peculiarly adapted for the endering of divers compositions in which arved forms predominated; whilst straight ine forms, stripes, checks, trellis patterns, nd powderings of spots which grew, almost aturally, through the crossing of different oloured wefts and warps, were more readily roduced by shuttle-weaving than by emroidery, and were therefore woven, and not mbroidered. By needlework, it was practically possible to render any kind of ornament in textile materials, but by weaving, the kind of design or pattern was limited. In both cases, however, through the regard for the nature of the materials used, and through other causes, such as symbolism and meaning in ornament, the range or style of ornament fluctuated but little. Certain conventionalities were adhered to for very long periods, so far as concerned the composition of, and details in, ornament produced by early Egyptians and Assyrians; and this fixity of fashion in ornament no doubt helped in conserving the two principal methods of embroidery I have alluded to. Now this conservativeness is in striking contrast to what would be seen, were we to review a series of examples of European embroideries produced during the last 400 years. We should find that their styles of ornament and methods of needlework abounded in changes and modifications almost innumerable. This changeful and vivacious European period is, therefore, in antithesis to the sedate and conservative Egyptian and Assyrian periods.

Now something of the same changing character seems to mark what, for present purposes, I will call the Grecian period of embroidery; and whilst we shall detect the use of the darning and patchwork methods in Grecian embroideries, we shall find a free use of other methods, well suited to new varieties of ornament, invented and developed from earlier sources by the Greeks. To broadly illustrate this change of style in textile ornament, as between Assyrians and Greeks, I have made a few sketches of typical ornaments ordinarily employed on their textiles by these two nations respectively.

According to this diagram (Fig. 1), Assyrian ornaments (for a period from 880 to 550 B.C.) for textiles consisted principally of simple devices, to be arranged along bands and borders, or in orderly powderings. As I have previously pointed out, fringes were generally worn on the edges of skirts in Assyria. They are rarely met with in Egyptian, Grecian, and Roman costumes. The devices in the first two borders are simple loop forms, set out singly. The third border has an upper set of these single loop forms repeated above recurrent oblongs, in the centre of each of which is a daisy. Such daisies or rosettes—as we have seen—were also powdered over stuffs. All these curved devices were probably inwrought or darned into the stuffs. The series of squares represents a frequent and

simple textile ornamentation, which, as we saw it with Egyptians of 2,000 B.C., and later, was probably the outcome of shuttle-weaving. The vertical band of and chevron forms, also, was probably of shuttle-weaving; but the border to the right of it, with radiating palm device and daisy blossom repeated in alterna-

FIG. 1.



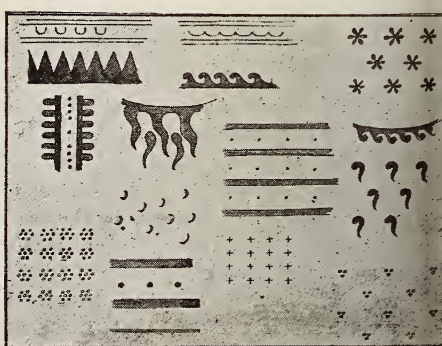
BORDERS AND OTHER PATTERNS ON ASSYRIAN COSTUME OF THE 9TH TO 7TH CENTURY B.C.

tions, was embroidered with darning or inwrought needlework. Far more intricate ornament, reserved, apparently, for the robes of kings and dignitaries, included sedately-conventionalised winged and other figures, sacred tree devices, and so forth. So much, briefly, for Assyrian ornament and its comparative limitations.

From a fewer number of sources than those I consulted for the foregoing Assyrian ornaments, I have selected these Grecian examples. (Fig. 2.) The familiar varieties of the rectilineal key-patterns, or squared continuous scrolls, are purposely omitted. Curved line devices are for the most part, here given, and some were probably embroidered on to the stuffs in long and short and chain stitches.* I mention these stitches, because they will be found in specimens of Greek needlework, which I will presently show. In the first of the two upper borders we have single curves, much lighter in effect than any of the Assyrian ornament The second border has a waved line, suggesti of continuity in ornamental line, a quali almost absent from either Egyptian or Assyri ornament. This waved line was apparently simple stitch embroidery on to stuffs. Tl pointed tooth-shape border is usually indicat in the designs on Greek vases as being dark or lighter in colour than that of the stuff adorned. Such a border would be suitab rendered in patchwork; I am doubtful if would bave been of *appliqué* work, ar whether that kind of work was ever in vog with Greeks; I hardly think it would have bee as it would have tended to load and thick textiles in a manner opposed to the apparent prevalent sense of appropriately using material Next to the dentated or tooth-shape border is familiar Greek ornament, the continuous wa device. This again is generally different colour from the stuff it adorns. It too mig have been of patchwork, but its curving charact makes it more likely to have been darned or i wrought, as were the flame and tear forms ne it. The various spots and bands with spots b tween them may have been of shuttle weavin whilst the other curved devices used as orn ments scattered, irregularly and regularly, ov stuffs were, I think, darned or inwrought.

We may, therefore, fairly conclude th Greek ornamentation for textiles occasion the use of methods of embroidery more nume

FIG. 2.



TYPES OF GRECIAN TEXTILE ORNAMENTS.
6th and 5th centuries B.C.

ous than those chiefly in vogue with Egyptia and Assyrians. Not only were inwrough darning and patchwork methods applied to t rendering of new ornamentation that spra from the lively genius of Greek designers, fr quently influenced by earlier designers, b stitching on to stuffs became more commo

* Since writing these lectures, I have, through the kindness of Mr. A. Higgins, seen a good many photographs of the coloured Grecian sculptures (dating from before the Persian invasion of Athens, early in the 5th century B.C.), now in the Museum of the Acropolis, at Athens. The patterns (picked out in colours) on the dresses of many figures are various, and their appearance leaves little room for doubting that they were of the darning or inwrought needlework, done with coloured worsteds into linens. They are valuable links in the history of textile ornamentation.

an it had been with Egyptians and Assyrians. new phase in embroidery thus seems to have ·isen. Whereas ornament in the inwrought-ırning was an integral part of the fabric it lorned, and whereas by patchwork an entire ıd ornamental fabric was made, embroidery ı to stuffs was an addition to an already ›mpleted stuff, and was merely an embellish-ıent.

I fancy that little is known of the intimate istory of Egyptian and Assyrian embroiderers. 'f the Grecian, however, we certainly know ıore at present, and one of the noticeable ıcts is the indication of the widely spread mployment of women in connection with ıe textile art, both in its ornamental and tilitarian aspects. To this fact is due ıuch of the variety in methods of Grecian mbroidery. One naturally turns to the)dyssey or Iliad as the earliest sources of ıformation in this respect, and there we find good many references to Grecian weaving nd embroidery and the employment of women ı those arts. But in making use of such re-ːrences we have to remember that in countries ear and practically adjoining to Greece there ʼas a wide-spread practice of the arts long ·efore Homer was in existence—further, hat of the Homeric poems, the version o which we are accustomed dates from he 6th century B.C., when Pisistratus, yrant of Athens, caused the poems of Iomer, previously in a state of confusion, to ›e brought together and written in the form ıow known. The domestic incidents in them ıre, therefore, probably flavoured with views ›f life in the 6th century B.C. In addition to his we should remember that Homer, who is eputed to have lived about 1000 B.C., is ;enerally considered to have been an Asiatic Greek. Consequently, it is likely that Asiatic ›r Oriental influences have entered into the lescriptions of ornaments of all sorts, as well ıs of methods of work given in the Homeric ›oems. Penelope throughout the day "weaved ın ample web, but in the night, by torchlight, ınravelled it." Her weaving, according to ı design on a 6th century Greek vase vas of the nature of inwrought ornamental vork on hanging warps, rather than of plain ›huttle weaving on stretched warps. So also vas that of Circe, who "sang with syren ʼoice, whilst weaving fabric large, fine, ›plendid, beautiful." Ulysses wanders in the ›alace of Alcinous and comes upon female lomestics "a few whereof did grind the ʼellow corn, in hand mills; others sitting wove the web" . . . . "like, as Phœacian men excel all else to guide ships o'er the sea; their women do in weaving webs; the Goddess Pallas hath gifted these with most ingenious minds to form fine works most beautiful in art." Again, how suggestive of ornamental skill in textiles, is Ulysses' description of his "fleecy purple cloak" . . . . "with double cape; and button of wrought gold; which had two loops. Its front had cunning work: a dog in forefeet held a spotted fawn, gazing upon it gasping—wonderful, though being of gold. He gazed upon the fawn, while strangling it; and, eager to escape, the other struggled, quivering with his feet." I know that some translators have decided that this hound and fawn incident was wrought upon the gold button or clasp of Ulysses' mantle, and not upon the mantle itself; but there are as many other translators who determine in favour of the hound and fawn having been embroidered in gold and coloured threads into the mantle. Pope and Chapman are among the latter; and Wakefield's notes to Pope's translation seem conclusive in favour of the embroidery. Of recent translators, Butcher and Lang incline to the ornamentation of the gold button. Certain it is, however, that amongst some of the earliest embroideries extant, this incident of one animal springing or preying upon another is given. Many references by Greek writers to ornamental inwoven needlework, as well as to women's part in carrying on the art, might be quoted; enough perhaps has been given to indicate that at an early date Grecian women were peculiarly skilled in ornamenting stuffs. In the 5th century, and earlier, the women's rooms in the houses of the Greeks were called gynecia, and the mistress of the house superintended the women at work. She, like Pallas with the Phœacian women, instigated her work women to produce divers ornaments of cunning work in textiles. Up to the times of the Roman emperors this domestic interest, in embroideries and such like, continued. But Roman matrons were not as faithful to it as their Grecian predecessors had been. The use of the name gynecia was kept up, but almost entirely in respect of public or tradesmen's workshops, which during the 3rd and 4th centuries A.D. became subject to Governmental regulations. In these the *gyneciarii* were those who wove imperial robes with golden and silken threads—for by the 3rd and 4th centuries A.D. silk had come into use for the making of costly costumes in Rome; though not until after

Justinian, that is in the 6th century, was it more freely employed.

Let me, however, return to the 6th century B.C. with its linen, worsted and golden threads, and show a diagram from Miss Harrison's new work on Greek vases (Fig. 3). It represents part only of the design in black and red, painted and scratched upon the inside of a flattened bowl. The centre is occupied with the design of a hero (Hercules probably) struggling with a marine monster (Nereus). The border consists of a string of dancing women hand-in-hand capering after each other. There are varieties of simple patterns on their dresses. Those which are powdered or scattered, and diapered, are more likely to have been (shuttle weaving. Dresses of a light colo have borders along the skirts, and thes borders have ornament which was probably (the darning inwrought needlework. The orna ment on the dress of one of the figures to th right is a diapering of scale forms, which wer rather of chain-stitch needlework than (shuttle weaving.

The next illustration, also from a vase give in Miss Harrison's book, represents Danaë upo a couch with the golden shower falling on he Her many folded costume has a dark-coloure bordering, another variety of which may b noticed on the veil or head-dress hanging jus

FIG. 3.

DESIGN ON A GRECIAN BOWL OF THE 6TH CENTURY B.C., SHOWING DIFFFRENT TEXTILE ORNAMENTS IN THE DRESSES OF THE DANCING FIGURES.

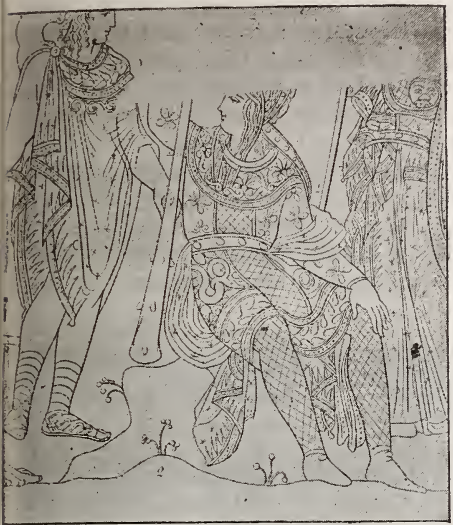
beyond the end of her couch. These borders were probably of the darning inwrought needlework. The covering of the couch has a pattern of trellis and crosses, and this was possibly of shuttle weaving. The vase upon which all this is depicted is of the 5th century B.C.

From another Greek vase, in the Hermitage at St. Petersburg and of a slightly later period, perhaps early 4th century B.C., I have taken this group of gods and goddeses. The ornamentation of their robes (rather faintly reproduced) is a good deal richer than that previously seen. The continuous wave scroll is used a good deal here as an edging to bands containing spots or tear shapes. These would be, I think, of darning inwrought needle work.

Of about the same period of Greek art—4t century B.C.—as that of the group we have ju looked at, are the fragments of Græco-Scythi embroidered stuffs which I mentioned in m first lecture. The first of them is a bit of re woollen material, with two bands of repeate bell blossom or calyx forms. These are of th darning inwrought needlework, done with re green, and yellowish woollen threads. Th type of ornament differs a little from what ha been previously seen; but much of this diffe ence is due to the effect of such design when worked, as here, in actual material

ıd not merely sketched in outline upon a ıse.

FIG. 4.

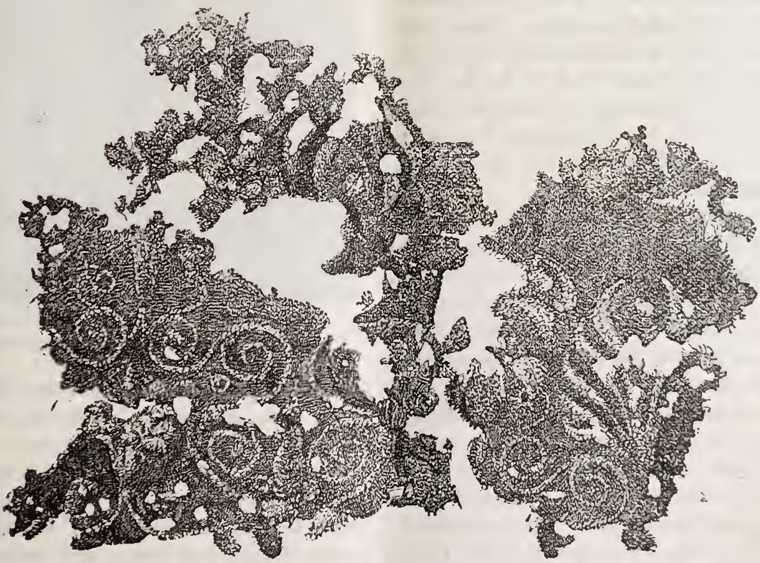


ERCULES SEATED: PORTIONS OF OTHER FIGURES ON EITHER SIDE OF HIM.
m a Grecian Vase. About late 5th or early 4th century B.C.

Very probably of similar needlework and naterials were the ornamental features of the skirt, and shoulder covering, of this figure of Hercules. (Fig. 4.) In these we find diversity of motives. The cloak on which he sits is bordered with the vandyked shapes which we found in Grecian ornament of two centuries earlier. Upon the skirt of his tunic we see a snake ornamentally treated; below it, is a bordering of repeated leaves. His cape is rich with its band of honeysuckle, or radiating ornaments, alternating with spreading lotus flowers. Blossoms, with four petals, are scattered over the stuff of his sleeves and body. All these I take to have been of coloured thread darning, and probably gold may have been introduced to heighten the effect. To the right is part of a figure of Minerva, with the gorgon mask on the upper portion of the dress, which is powdered with crosses and edged with vandykes. Vandykes occur upon the dress of the third figure —the one on the left, towards whom Hercules is looking. This, perhaps, is Mercury. His cloak, like Minerva's robe, is powdered with crosses, and edged with vandykes, whilst to the upper semicircular piece, there was an outer edging of the familiar continuous wave scroll, of which a portion only remains in the diagram.

Here are two more of the Græco-Scythic

FIG. 5.



GRÆCO-SCYTHIC CHAIN STITCH EMBROIDERY ON A STUFF.
About 5th or 4th century B.C.

fragments. (Fig. 5.) It is somewhat difficult to perceive at first what the ornament on them is. But the eye, growing accustomed to the fragmentary effect, soon realises the beauty of the ornament and the general effect of such work as it appeared originally. The embroidery is of chain stitch, with threads of yellow linen, I think, and the ornament is of radiating honey-

suckle devices and convoluting stems, lighter in effect than more solid ornament usually done in darning inwrought needlework.

The dainty ornament on the tunic worn by this figure of Paris, with his Phrygian cap, seems to me to have been so embroidered with chain stitch, and probably with golden-looking threads of linen or worsted. His close-fitting sleeves and leggings, or pantaloons, were, I think, of shuttle-woven material, whilst his cloak, with tear shapes and vandyke edge, was probably of inwrought needlework. The draperies of Helen and her attendant are without embroidery. This group is from a Greek vase of the 3rd or 4th century B.C., preserved at St. Petersburg.

I am afraid that it is something of a task to attempt to grasp the interesting and technical information conveyed by this photograph, taken from the last of the Græco-Scythic fragments. However, I will briefly describe it. The stuff, upon which there are rather obscure indications of embroidery, is a thinnish shuttle woven stuff of rather dull red colour. It is bordered on the lower part with fragmentary darning and inwrought needlework of worsted, thus proving that this method of needlework was used with other and different embroidery on the same fabric. On the specimen before us the indications of such other embroidery are found to be of long, short, chain, and cross-stitches. When the embroidery was in tact, it represented a man on horseback. He wore a short tunic, with an ornamental border. His left hand held the reins, and his right was uplifted behind him; his horse was apparently prancing.

And now let me point out the actual indications of what I have described. Here, first of all, is the horse's head; here the indications of his legs; here is the man's head; here his left arm and shoulder, fairly complete; here are his feet, and here the border to his tunic; above are the remnants of his right arm and hand. In this tattered rag we have evidence of how human figures and animals were sometimes embroidered by Greeks in the 4th century. As an ornamental device, the horseman is distinctly Scythic or Persian; it survived for many centuries subsequently, in later Greek and Roman designs strongly influenced by Oriental traditions.

Less Oriental in feeling, and more strictly Grecian of the 4th century B.C., are the ornaments on these fragments of sculptured drapery recently discovered at Lycosoura, in Arcadia, and described in a pamphlet, entitled "Fouilles de Lycosoura," published at Athe in 1893, from which I have ventured to tal this illustration. (Fig. 6.) The forms are in lo relief, but I do not suppose that this relief corr sponded with, or was intended to convey a impression of heavy raised embroidery. Tl earliest raised or padded embroidery I knov dates from many centuries later—the 14th o 15th century A.D. at earliest. There is grea diversity of ornament in this 4th century B.C sculpture of Grecian embroidery, and judgin from what we have seen I should say tha much of it was (originally, in the real stuff) o chain, long and short stitches. The uppe

Fig. 6.

Sculptured Ornamented Drapery.
From Lycosoura. 4th century B.C.

portions are decorated with bands of ornament, free in style, and not of such formal arrangement and severity as were noticeable in the suggestions of 5th and 6th century embroidery. In the bands are birds, sprays of olive leaves, mythological female figures mounted upon sea horses and fish-tailed personages; both of the upper portions are edged with a graceful little ornament of heart shapes or small discs, and little pendant or tassel devices hanging down from them. This edging was probably of darning inwrought needlework. Upon the larger, lower spaces of the drapery we find Greek female figures bear-

g pedestals surmounted with vertical ornament grasped by the right hands of the female figures.* Springing up vertically in front of one of the women will be noticed a spray of olive leaves and berries, which is at right angles to a corresponding spray running horizontally. Beneath this comes a band of small grotesque figures, and below this, finishing the edge of the drapery, is the continuous wave scroll, which latter would be appropriately of inwrought needlework.

And now I come to a break of two or three centuries in my series of illustrations. The period of the richly ornamented drapery from Lycosoura may be said to be that preceding the time of Alexander the Great, *i.e.*, the later portion of the 4th century B.C. One result of his conquests and settlements in Asia Minor, Syria, Egypt, Babylon, Persepolis, Bactria, Cashmere, and the Punjab, was the infusion, into Grecian ornament at least, if not also into Grecian methods of work, of a mixed Oriental feeling, as well also as the diffusion of Grecian spirit in certain sections of Oriental art, and instances of these could be readily quoted. I must however restrict myself to embroideries, and in these the readiest to hand are samples of Egypto-Grecian ornament produced in the pervading method of inwrought darning needlework.

The first of these is the inwrought ornament to a neck trimming, perhaps of the 1st century B.C. or A.D. It comes off an Egypto-Grecian tunic, and the prominent ornamental feature in it is a series of Grecian honeysuckle or radiating devices. It was found at the disused cemetery at Akhmîm, near the Nile in Upper Egypt. Akhmîm is the modern name of the old Grecian town Panopolis or Chemmis, which was well-known to Strabo and Herodotus.

The next piece (from the same place) is a fragment from a Grecian or Roman tunic of shaggy linen material, of which latter Pliny gives a description. The circular panel rested upon the shoulder of the wearer—the two bands below it run along the extremity of a short sleeve. The little dancing figure (not unlike some of the grotesque figures in the Lycosoura sculpture) perhaps represents Mercury. Around the panel in which he appears is a series of pointed bud shapes. The playfulness of the design is Grecian, and might suggest as early a date as the 1st or 2nd century B.C. for the origin of the piece. But the waved stem and leaf ornament along the sleeve is of a heavier character, and seems to imply a later influence, consequently the whole of the piece belongs to a later date—possibly the 2nd or 3rd century A.D.

Another style of decoration is shown in this diagram on the screen—a photograph from an inwrought worsted panel, with a portrait in it. This, again, is also probably of the 2nd or 3rd century A.D , and of Egypto-Greek or Roman work; but it might very fairly be accepted as a specimen of the tapestry heads or portraits described as having adorned the hangings in the Palace of Ptolemy Philadelphus in 3rd century B.C.

The very great skill exhibited in the Egypto-Grecian and Roman inwrought or darning needlework is, more remarkably, displayed in specimens of later date, and of altogether different style of ornament. This piece is probably of the 7th or 8th century A.D., and is a mixture of late Roman and Mohammedan styles. The dainty workmanship of the fine white-lined geometric patterns is far beyond anything comparable with it in modern needlework. The whole of the specimen is actually not much more than two feet square. The elaboration of the ornament in it is well worth close examination. Take one of the corner portions: first comes a plain narrow bordering to a band, barely an inch wide, filled with double-lined interlacing angular stems; between each of the interlacings is a small outlined cross. A plain bordering comes next, and then a broader band with double-waved stems interlacing one another and worked into it. In each interlacement is a ten-petalled blossom. A delicate cable pattern is picked out in white threads upon the interlacing stems, and so on. The darker portions of this piece of wool, and the bright lines are of linen thread.

The next specimen is of similar darning needlework, and is even of finer texture, due not only to the great skill of workmanship, but also to the employment of silk threads, far smaller than the linen ones of the previous specimen. The ornamental shapes are of a poor degraded style; but this defect is compensated for by the beautiful contrast of the colours, chiefly red, yellow, blue, and black. This is a piece of Saracenic needlework, belonging to the period of the Khalif Al-Mustansir billah, who was living in 1047 A.D. A number of such inwrought needle darnings with silks on linen threads have been brought to light recently. Into some are worked Kufic inscriptions, such as, "In the name of God

* These are barely traceable in the illustration, though they were well seen in the lantern slide.

the Merciful, the Gracious;" "There is no God but God;" "Mahommed is the Apostle of God;" "Ali is the favourite friend of God;" "Al Mustansir billah, Prince of the Faithful, the blessings of God be upon him, upon his fathers, the pure Imams, and upon his sons." Apart from the delicate texture of these later specimens of inwrought darning needlework, let it be noted that the employment of this particular method of needlework has now been practically demonstrated to have existed for fifteen hundred years, from the Græco-Scythic specimens up to those of the date of this Khalif Al Mustansir billah; whilst, for at least as long a period previously to the 3rd or 4th century, B.C., the embroiderers of Canaan, of Babylon, and of Egypt had apparently also pursued it, although with different materials, and in rendering very different sorts of ornament, into all of which, however intricate, curved forms entered.

The remaining illustrations of this lecture are of embroideries recently obtained from Pagan-Roman and Christian burial places at several places in Egypt. To do full justice to them would require considerably more time than is allowable; they call up many associations which, if properly treated, would form an epitome of events in respect of Roman rule in Egypt, the early Christian church, and its numerous sects, the Arab conquest, and the decay of the Byzantine or Eastern Roman Empire.

Amongst these embroideries there are hundreds of the inwrought darning work. In addition, however, there are several pieces of other work in which the embroidery is stitched on and into woven stuffs. Few of these other embroideries differ, technically, from those noticed as gradually developing through the ingenuity and taste of the Greeks; and the preponderance of the Pagan, Christian, and Saracenic specimens is of coloured wools and linens, just as was the case with the needlework of ancient Egyptians, Assyrians, and Babylonians. Those worked with silks belong to the later of the times that I cannot touch upon.

Here, now (Fig. 7), is a little specimen of Egypto-Roman embroidery with brown wool, in long and short stitches worked on to linen. The design is of a Roman double-handed vase, the handles terminating in leaves. This small panel was one of a set of four that ornamented the skirt of a child's tunic.

My next example presents another kind of needlework. I referred to it in my first lecture, and connected it with Assyrian or Babylonian rugs. Here, however, this cla of needlework is used for another purpo namely, for a loose linen cloth which may ha been worn or else thrown over a seat. T woollen embroidery consists of longish loo left projecting upon the surface of the lin into which they are sewn, and forming a rais ornamentation. In this piece the ornament composed of a number of single heart shap or rose-blossom petals, variously coloure pink, red, and green, and placed at regul intervals from one another. The same pet device, repeated in a close order, runs alo the border.

Fig. 7.

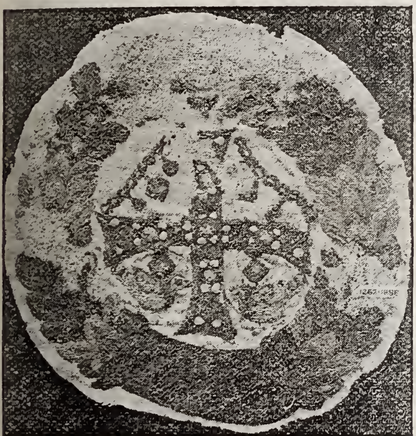
Small Vase and Leaf Ornament of Long an Short Stitches, with Wool on Linen.
Egypto-Roman. About 2nd or 3rd centuries A.D.

This is a comparatively simple ornamenta tion; a more elaborate one is seen in this ne illustration on the screen, which represents tw cupids in a boat, surrounded by a border of ove lapping leaves, with a man's head or mask in i corner. The original, in the British Museum is of the looped worsted embroidery, and i date may be placed as early as the 3rd cen tury A.D., if not earlier. The design, espe cially of the border in connection wit a figure composition, recalls that of th work done in the embroidery or weavin competition between Minerva and Arachne the incidents of which are told with conside able detail by Ovid.

The earliest Christian embroidery, that is t say, ornamental needlework presenting em blems of Christian significance (similarly wit other branches of Christian art) directly re flects methods of work and schemes of orna ment prevalent with the various non-Christia people amongst whom the Christian fait gradually had taken root and grow, blossoming

ıriously according to the cults of local sects, · different schools of thought. In a piece like is, of inwrought needlework, we find a omanesque style of design—a square about circle—each of the corners filled with a sort ' acanthus calyx device, and the centre filled ith a large cross and four birds between the nbs of the cross. Of the same period—about h century A.D.—is this next specimen. (Fig.) This, however, is of rather close needlework

FIG. 8.



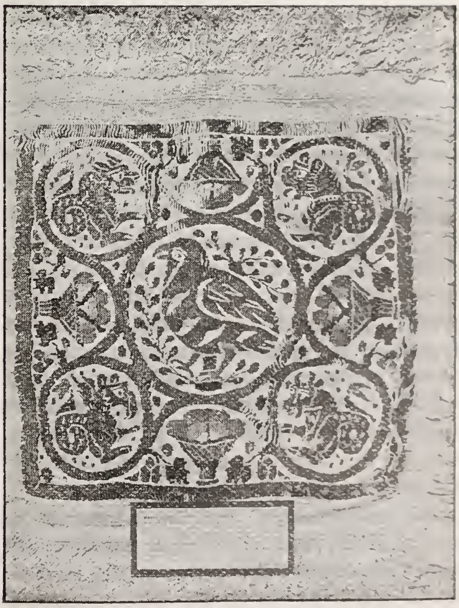
ONG, SHORT, AND CHAIN STITCH EMBROIDERY IN COLOURED WORSTED AND LINEN.
Egypto-Roman, 4th or 5th century A.D.

pon linen, for which bright red, green, and ellow wools have been used. The stitches are ng, short, and chain. A wreath encircles a welled cross, with chain and pendent jewels; n either side of the lower limb of the cross is dove. The style of the design belongs to ıe time of Constantine the Great, probably; ut it was a style that lasted for some centuries ıter, and the gold and jewelled visi-Gothic otive crown of King Recesvinthus of the th century, is an important evidence of the ırvival of this style, though in other mateals. The specimen here, however, is worthy f notice as a sample of 4th or 5th century mbroidery, loaded, as it were, on to a stuff nd for ornamental effect solely.

From the point of view of Christian symolism, the next three pieces of Egypto-Roman, or Coptic, inwrought needlework are ery interesting. The first of them has a series f the debased renderings of the Egyptian ymbols of life and fertility—the crux ansata r Ankh. Now, when the Temple of Serapis, t Alexandria, was destroyed in the 4th entury A.D., Christian writers of a hundred years later recorded that many of such venerated and Pagan symbols were found there, and, although known as such, fervent Christians did not disdain to imagine that these symbols might equally typify, prophetically, the redemption of the world. In consequence of this, a Christian meaning was imported into the Egyptian symbol; and, according to Sozomen (5th century), many Pagans were duly impressed with what they were told concerning the new meaning given to their old symbol, and were thereby converted to Christianity. Besides giving a new meaning to the old symbol, its representation was subjected to changes, as we see here by the introduction into the loop, upon the tau cross, of Christian crosses and of stars, &c.

In the second piece we find the old Egyptian symbol again, but with a face inserted in the loop of the ankh. Two Romanesque vases stand below the horizontal limbs of the cross, and a smaller vase is placed on each side, above the loop. The continuous wave stem and leaf bordering is, of course, but a poor survival of the more graceful Grecian device of the same construction or design.

FIG. 9.



SQUARE OF DARNED OR INWROUGHT COLOURED WORSTED EMBROIDERY INTO LINEN. SYMBOLS OF THE EVANGELISTS AT THE CORNERS.
Egypto-Roman, 5th century A.D.

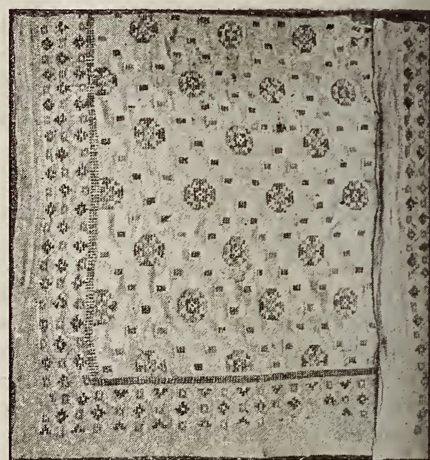
The third of these Christian inwrought needleworks is probably of the 5th century A.D., the scheme of the pattern is Roman. (Fig. 9.)

In the centre is a red-legged bird, perhaps a partridge, which is said to be connected with a legend concerning St. John. In each of the corners is a fish-tailed creature, each with a different head. One is a bull's head, the emblem of St. Luke; the lion's head for St. Mark; the eagle head for St. John; and the last one, apparently a dog, stands evidently for St. Matthew. It is interesting to note here that certain of the emblems of Ptolemaic Serapis, *i.e.*, the chief god invented by Ptolemaic Greeks to take the place of the venerable Osiris of Egypt, were akin to these fish-tail and animal-headed creatures; and it is certain that the Christian emblems we are now looking at were made not so very long after the extinguishing of Serapis worship at Alexandria. From the mere ornament point of view, these Christian emblems seem to owe something to the Pagan emblems of Serapis. In later emblems of the evangelists, St. Matthew is represented by a man's head, according to St. Jerome, but elsewhere an angel typifies St. Matthew. St. Augustine held that the lion symbolised St. Matthew, and that the man's head, or angel, stood for St. Mark. However this may be, the inwrought needlework before us is of great interest to Christian iconography, and may be worth elucidation by some authority upon the influences that may have been brought to bear upon designers of symbolical ornament by such varied Christian sects at Alexandria, as the Monophysites, the Nestorians, the Jacobites, &c.

It looks like bathos to descend from such engaging topics to simple needlework again; but it is desirable for me to refer to a few examples of Saracenic embroideries which help to develop the general story of the growth of embroidery. Kindred to the inwrought darning process is such work as this, in which the pattern is simply darned into the linen, and does not help to complete the fabric itself. This work possibly dates from the 7th century, A.D., and of course is like much that is made now-a-days.

Of the same class of embroidery, but more ornamental, is this linen cloth with small squares, forming a subordinate trellis pattern to the blossom shapes placed at the centre of one of which is each lozenge space (Fig. 10.) The colours of the worsteds are light blues, greens, and browns. This, too, is needlework of the 7th century, found in Egypt. This class of ornamentation was also worked in the inwrought darning method, as in this next piece. Here we find a subordinate trellis pattern, or general framing, within whic[h] are different devices, some suggestive [of] blossoms, some of trees and leaves; other[s] again, are circular panels, with star form[s] in them; and some of these star form[s] are Saracenic in style. Within the border [of] this cloth are a number of small forms, whic[h] appear to be derived from the peacock feathe[r] with its dark central spot or eye. You wi[ll] notice, too, from the parts from which th[e] coloured wools have disappeared, that th[e] darning, or inwrought work, was limited t[o] those spaces which had been left uncrossed b[y] weft threads, as the entire linen was woven i[n] the shuttle loom. As I have already remarked in respect of previous pieces of the same clas[s] of needlework, the inwrought wools complete[d] the entire fabric, and were not darned into [a] completed stuff. The two different method[s] of darning were concurrently used at the sam[e] time we are now dealing with; but I think i[t] has been shown that one has an older origi[n] than the other.

Fig. 10.



Saracenic or Egyptian Ornamental Darnin[g] of Coloured Worsteds on to Linen.

About 7th century A.D.

Further examples of stitching on to and int[o] a finished woven stuff are given in this nex[t] slide. The upper band is embroidered wit[h] black wool, in short and satin stitches. It i[s] Saracenic work of the 7th or 8th centurie[s] A.D., and came from Erment, in Upper Egypt. The next band below is embroidered with blue, green, and brown silks, in short and lon[g] stitches. This is of the same date, is Saracenic, and comes from Mataieh, in Uppe[r] Egypt. The third bit is of darning embroidery,

hilst the fourth is of short or tent stitches, iving an outline effect, a much lighter one ıan that of the fuller work in the third piece.

The next slide gives us a part of a linen ress or cloth, embroidered with coloured silks ı long and short and chain stitches, with two orizontal bands of crosses and geometrical rnament, one of which is bordered on each de with a row of palm trees with a pair of irds at the base of each alternate tree. etween and beyond these trees are scattered numerous small forms, such as pairs f crowned figures seated, peacocks, other maller birds, lions, crosses, leaves, and iangular emblems. Towards the lower part re three roundels, with borders of illegible Cufic characters. This is, perhaps, of Coptic ork of about the 10th century A.D., and omes from Meshaieh, near Girgeh in Upper Egypt. The use of silk in it gives it special nterest.

FIG. 11.

PART OF AN EMBROIDERED ROUNDEL TO A DRESS.
Probably 7th or 8th century A.D. and Byzantine in style.

Of close, long, short, and chain stitch embroidery is this portion of what was once a oundel (Fig. 11), some 9 inches in diameter, illed with figures of personages, wrought in ilks of brilliant crimson, yellow, green, &c., he forms of the figures being outlined in black silk. Such style of ornamental figure composition doubtless belongs to a later period of the Byzantine empire, say the 7th or 8th century. But it had been in vogue for a century or two previously. Rich persons adopted sacred subjects to be embroidered on their costumes; one senator boasted of having at least six hundred figures upon his robes of office. And in the 5th century, Asterius, Bishop of Amasea in Pontus, preached at the vain-glorious "who wore the Gospels on their backs instead of in their hearts. Every one," he said, "is eager to clothe himself, his wife, and his children with stuffs ornamented with flowers and numberless figures, and to such an extent is this done, that when the wealthy classes show themselves in public, little children gather round them in crowds and point their fingers at them, making merry at their expense. The more religious of the wealthy classes require artists to supply them with subjects taken at their suggestion from the New Testament, of Jesus Christ and his Disciples, or else from his many miracles."

I conclude my series of illustrations with the well known group of the Empress Theodora and her suite, taken from the famous 6th century mosaics at Ravenna. The ornamentation of the dresses will be seen to be plentiful, though not so extravagant as that seems to have been which Bishop Asterius denounced. Figures of the Magi bearing offerings appear along the border of the Empress' cloak; on the skirts of her attendants we see trees or else birds profusely scattered in regular series, reminding us of that bit of Græco-Scythic inwrought stuff figured with ducks, which we saw in the first lecture. The cloaks are dotted over with small blossoms or crosses, or else covered with a pattern of repeating circles and such like. The dentated or vandyke bordering, such as we saw in Greek costume of some 1200 years earlier, is to be found amongst the ornamentation, so, too, is a trellis pattern not unlike that on the cloak of the figure of Egyptian Osiris shown in the first lecture. Much of this variety in ornament was done according to the long surviving inwrought darning into a stuff, whilst some was of later long and short stitch embroidery on to a stuff; other of the ornament was, perhaps, of simple shuttle weaving. The whole illustration, however, is, I think, a suitable one with which to conclude my diagrams this afternoon.

I feel that my suggestions upon means for verifying ancient embroideries have been of a slight character; still, I hope that at least they are not misleading, as far as they go. I think you will agree with me that the subject generally is one that has very many and far-

reaching ramifications. It is certainly one that I should like to pursue very much further.

Means for verifying laces will be the subject of my next lecture, and I think that we shall find that lace is a not altogether remote offspring of weaving and embroidery, although so different in appearance from both.

Miscellaneous.

CULTIVATION OF LUCERNE IN CHILE.

Lucerne, purple medick or alfalfa (*Medicago sativa*), is said to be one of the most important of the agricultural products of Chile. In the districts where there is little rainfall it takes the place of grass in irrigated meadows. When dried like hay or clover, and compressed for purposes of carriage, it forms the chief food of cattle and horses in the dry provinces. This hay or "pasto" is exceedingly nourishing, but is considered more fattening than British hay, which would therefore probably be more suitable for horses if it could be procured cheaply. But it is excellent food and horses get little else, except those of the richer classes.

In 1892, during the hay famine in the United Kingdom, some alfalfa was exported to England and landed at Liverpool and Glasgow at £4 10s. a ton; it is said, however, that there was some prejudice against it and that stones were maliciously put into the bales, which made it unpopular. No one, however, acquainted with the endurance of Chilian horses would long entertain any prejudice against the fodder.

The crop, which in the drier districts is grown entirely by irrigation, is enormously productive, three and even four crops a year being taken, and such is the richness of the soil that many of the alfalfa meadows have been worked for from 12 to 15 years without being tilled or the plants renewed, and without being manured.

One large alfalfa farm near Santiago is said to have 6,000 acres laid down with the plant, and the actual production is 1,500 bales a day, which it is expected will be augmented to the extent of another thousand, thus making 2,500. Two large sheds contains the machinery and serve as stores for the compressed hay and are lighted by electricity. There are on the farms 500 oxen for the carts, 220 horses for the mowers and rakes, and 200 for the use of the head waggoners and overseers. There are in all, including animals for breeding purposes, 2,500 horses and 8,000 sheep.

THE USE OF DOG-SKIN FOR GLOVES IN GERMANY.

On account of its very fine texture and beautiful grain, dog-skin has been used for a long time in the manufacture of gloves, and for this purpose, says the *Deutsche Geber-Zeitung*, at the present time it is perhaps the most favoured of all leathers or the market. For the boot trade the tanners would, of course, use the larger skins in order to have the required size and a stronger leather than is used for the manufacture of gloves. The flesh side is somewhat harsher and less firm than is the case with calf-skins, but, on the other hand, the face is very fine, and the grain easily surpasses that of calf-skin. They are, as a rule, made black, and are handled in the same way as other black skins, but on account of the loose and delicate texture some precautionary measures must be taken in tanning and dressing them. The skins do not require so much lining, for example, as kip or calf-skins; it is therefore inadvisable, if there are large quantities to be dealt with, to treat them together with other articles. Extreme care is taken during the process of cleaning, for where the lime gets on a fine grain it is very difficult to get rid of all traces. The skins are kept in motion and the stirring continued in the fresh tan; this stirring is absolutely necessary if the grain is to come out even and regular. When the skins are practically tanned through, these are generally allowed to remain a little longer so that they may become more thoroughly impregnated with the tan. When washing and putting, the men work, as far as possible, on the flesh side, so that the fine grain may not be damaged. A mixture of one-third train oil, one-third tallow, and one-third dégras is fulled on the skins. For black, it is customary to use blacklead powder, but this must be exceedingly clean. After dyeing, the skins must be once more thoroughly beaten, first on the flesh side and then on the grain side, then oiled to prevent the grain becoming hard with the bla[illegible] Drying, after blacking, usually takes a long ti[illegible] and if care has been taken in preparing, tanning, a[illegible] finishing, the grain is usually superb.

General Notes.

KING'S COLLEGE, LONDON.—A new Departme[illegible] for Training Teachers for Secondary Schools will [illegible] opened next September. There will be a two yea[illegible] course of technical studies combined with the pr[illegible]paration for the B.A. degree of the University [illegible] London. Detailed instruction in the art of teachi[illegible] particular subjects will be given by the Professors [illegible] the College. Six exhibitions of £15 are offere[illegible] Names of intending students should be sent in befo[illegible] September 16.

ERRATUM.—In the obituary notice of the late M[illegible] J. H. Greener, it was stated that he was connect[illegible] with the construction of the Stockton and Darlingt[illegible] Railway. This was an obvious mistake. The Rai[illegible]way was opened in 1825, whereas Mr. Greener w[illegible] not born until 1829. It was his uncle, Thom[illegible] Greener, who was associated with George Stephe[illegible]son in the construction of that railway.

ournal of the Society of Arts.

No. 2,227. Vol. XLIII.

FRIDAY, JULY 26, 1895.

communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

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CANTOR LECTURES.

EANS FOR VERIFYING ANCIENT EMBROIDERIES AND LACES.

By Alan S. Cole.

cture III.—Delivered February 25, 1895.

[n a lecture upon means for verifying ancient nd-made laces, and one for which I find it cessary to have a considerable number of istrations, it will be advisable at the outset give a definition of lace. In the first place, s a fabric of itself, as a loom-woven stuff is, ugh in texture and appearance lace is quite ferent from a loom weaving. Lace is not an broidery on to a stuff, though very often it is eedlework, but wrought independently of a ndation stuff. It is distinctively an orna-ntation, and is not what is termed an article necessity. It grew from a desire to produce namental effects by adapting methods in ng loose threads to such a particular pur-se—methods, however, which for long periods d been used, and, indeed, are still also ed for useful as distinct from ornamental pur-ses. When lace began to grow, its growth der the hands of women was comparatively oid. We may look for signs of it amongst ch lovers of ornamental textile fabrics as the syrians; but the nearest approximations to are tasselled fringes, of which I now show an ample or two. The tasselled fringes were med sometimes by binding groups of loose eads together, and sometimes by twisting d plaiting them together, as in cords, braids, boot-laces. Knotting was also sometimes orted to. Twisting, plaiting, and knotting eads together are methods which are used making some laces. But it is obvious that Assyrian fringes cannot be called laces.

Again, to turn to other thread fabrics for king which other methods were used, let take such nets as we see in this sculpture of Assyrian hunters. The nets here shown were made by looping and knotting a continuous thread. Looping a continuous thread is also a feature in some lace-making.

I can find no evidence that Greeks of classical times made laces. They had nets, and nets of different kinds, thereby evincing some desire for variety of ornamental effect, in net. Suggestive of such varied nettings are specimens of Egypto-Grecian nets made, probably, about the 2nd or 3rd century A.D. Here, now, is a fragment of an oblong net. What its particular use was I cannot say; but there is ample indication of variety in the arrangement of the loopings and knottings. The next specimen (Fig. 1) of similar varied net work is circular, and was used, possibly, as a hair net. This, too, is Egypto-Grecian work of the 2nd or 3rd century A.D.

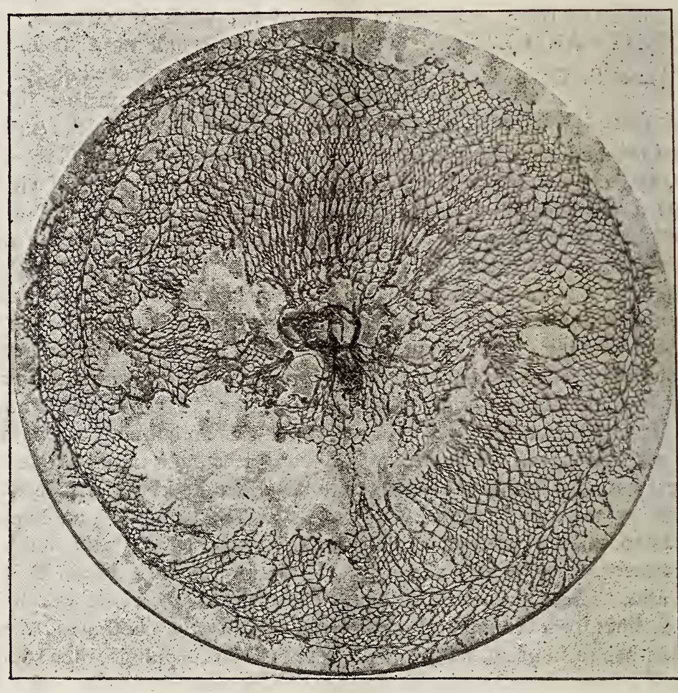
I believe that no further light, from times before the 15th or 16th centuries, can be thrown upon the origin of lace-making. From the mere process point of view it may be said that the progenitors of one sort of lace work were fringes, and those of another sort were nets. When, as in fringes, a number of of threads twisted, plaited, and interwoven amongst themselves are to be detected in a lace, then it is a pillow or bobbin lace; and here are a pillow with bobbins arranged for making lace. The pillow is of an ordinary type; but the size and shapes of pillows and bobbins have altered from time to time, and according to the different kinds of lace made at various places. The lace being made on such a pillow as this would be of a very simple character.

For making nets, I said that a continuous thread was looped and knotted. When in a lace we follow a continuous thread through a succession of loopings, then such lace is either needle or machine made. But with machine-made laces I cannot now deal. Laces made by hand are to occupy your attention. As regards the characteristic of looping in needle-made laces I show this diagram on the screen. In the upper strip you may just see the pattern drawn in outline upon a bit of paper or parchment. Below it you see part of this pattern with an outline of thread stitched on to it; adjoining it is part of the lace fully worked out in thread upon the pattern; and if we could look into this worked portion we should see that the whole of it was made by a series of looped stitches cast by the needle, first upon the original thread outline, and then amongst themselves and drawn together into compact textures. The lowest strip is of the lace made

from the design above, after it has been detached from its paper or parchment drawing. The relation of needlepoint lace to net is only in respect of the looping of a continuous thread, which operation is common to both. Needlepoint lace-making is, therefore, as high a development from net-making, as pillow or bobbin lace-making is of fringes. Thus it is only as regards methods that these several articles have a common parentage. When ornament, which, as I said, is a paramount element or feature in lace, comes into question, then the genealogical trunk of lace spreads off into distinct branches.

The sources of ornament for lace, as made, are to be found, for the most part the embroidery of white linens, canvases, square-mesh nets. This class of embroid arose under the influence of an extend use, and confection, of white linens in 15th and 16th centuries, when fancy taste dictated a demand for the ornam tation of such fabrics. Splendour in weav silks and velvets and cloths of gold been reached for centuries, but ornamen white linens were practically unknown; the attractiveness of white thread-work enrich white linens had not been experien

Fig. 1.

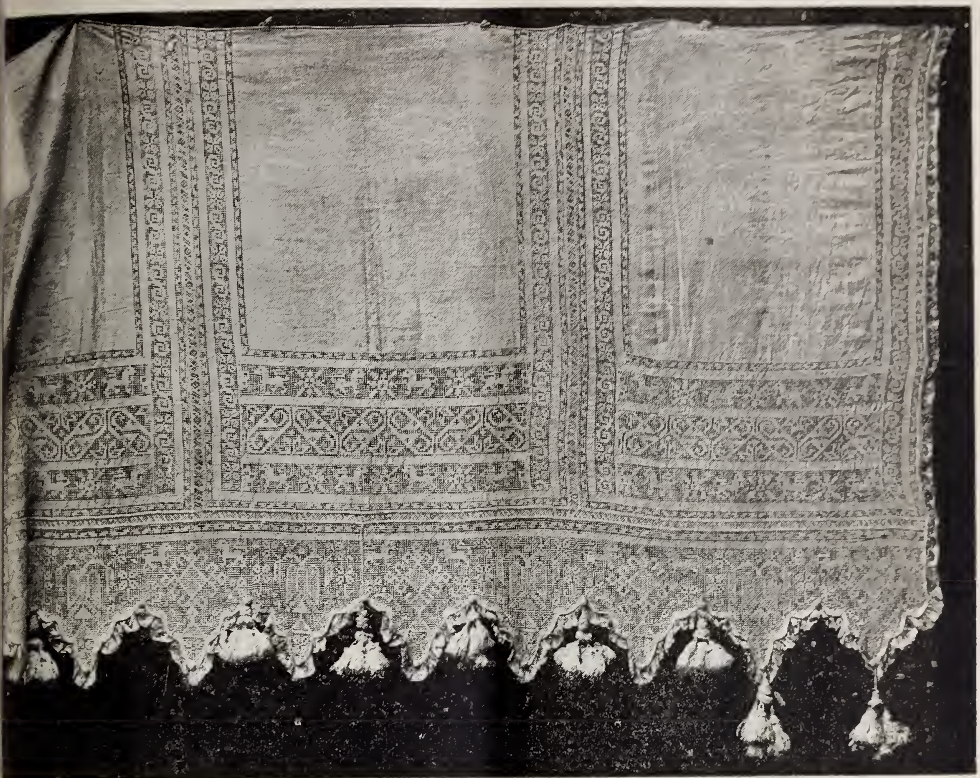


Net—Probably a Hair-Net.
2nd or 3rd Century A.D. Egypto-Grecian.

to any great extent Time allows me to show a few specimens only of this class of work, and those must be of a matured style, such as had been acquired by the commencement of the 16th century. In one branch of this ornamentation of white linens, threads would be pulled or drawn out to form interstices about ornamental forms left in the plain linen. And here is an example of drawn thread-work. (Fig. 2.) It is Italian, of the 16th century. As threads were pulled out, so those remaining would be whipped round, or prevented from fraying by buttonhole, or, in this case, whipped stitches. Here, on the screen, is another examp of drawn thread-work with whipped stitche this is Persian, and possibly of the late 15th early 16th century. Its ornamentation is co paratively simple, and perhaps hardly comme surate with the amount of careful work p into it. It is more than probable that fro such Eastern work, as well as from somewh similar work done in the Grecian Archipelag the Italian and other European art of drawi out threads and stitching over them w derived.

The next specimen of pulled or drawn threa

FIG. 2.



COVERLET OF WHITE LINEN, WITH BORDERING AND INSERTIONS, OF DRAWN AND WHIPPED THREAD WORK.

Italian. 16th Century.

work is an Italian linen cloth of the 16th century. (Fig. 3.) The ornament of the insertion in this piece is more varied than that of the Persian cloth, and is strictly of a geometric style. The plan of the ornament is a repetition of open squares filled in with devices arranged along and about the diagonals of the squares. To make the open squares, a great number of threads have been pulled out from the linen. Those which remain are overcast with looped or button-hole stitches, and thus converted into the thick vertical and horizontal sides of the squares; they may be tracked from the outer margin of plain linen on one side to the centre of linen within the open ornament work. The work between the sides of the several squares is of closely compacted looped stitches. The whole insertion of open ornamental work is practically identical with the earliest needle-point lace. The difference being that the thread-work in this case starts with the linen, whilst in needle-point lace you would draw a pattern on a bit of paper, and fasten tracing threads on to it, and then sew over and between them, and thus make a fabric independently of any foundation of linen.

The inevitable tendency of the drawn thread-work was to give a geometrical style to its ornament, and for a short time this style prevailed with lace-makers. Many books of patterns, published in the 16th century, contain instances of this geometric style. Here is a page of the repeated squares with varying star, rosette, and diagonal devices within them. These are for bands or insertions of geometric lace, which would be produced independently of linen, and only added to it afterwards as taste might direct. Here is another page from the same old pattern-book, and on this we have a series of tooth shapes or vandykes to be worked in lace as borders to the edges of cloths, or they might be, as they frequently were, joined on to the edge of

a lace border or band, and thus convert it into a deeper piece of lace.

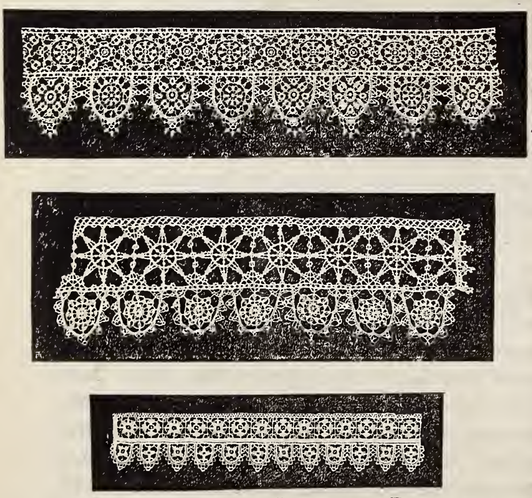
I have here a specimen or two of the deep vandyked laces, two of large proportions a

FIG. 3.

CLOTH, WITH DRAWN-THREAD AND BUTTON-HOLE STITCH WORK.
Italian. 16th Century.

one of much smaller proportions. (Fig. 4.) The rather stiff and wiry character of this geometric pattern lace should be noticed, as I shall have to return to it shortly in connection

FIG. 4.



VANDYKED BORDERS OF GEOMETRIC-PATTERNED NEEDLE-POINT LACE.
End of 16th Century.

with portraits, which are the means by which the dates, when this sort of lace was first made and used, may be verified.

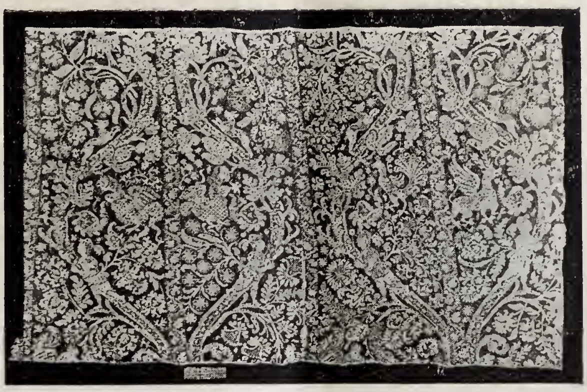
Before I show these portraits I must mention one or two other kinds of embroider those done on square mesh nets—there we no circular mesh nets in the 16th century- from which we gain suggestions of mor elaborate ornament than that of the geometri style of squares and rosettes and vandyke Here, then, is the end of a fine linen clot having insertions of square mesh net, int which ornament has been darned. Beside the darning into the net, we note in th intervening linen that some circles hav been cut out of it, and into them are intro duced little open wheel and star devices o needle-point lace. Along the edge of th piece is a simple bordering of vandykes wrought by plaiting and twisting threads This last is early bobbin or pillow lace.

A different kind of embroidery on net i shown in this next diagram. (Fig. 5.) Here the needlework is not simple darning, othe stitches are used; and the adoption of them enabled the worker to reproduce the flowing curves and intricate forms, flowers, birds, an fantastic figures of men and animals, &c. with more freedom than darning strictly according to the square meshes of the ne would permit.

Such varieties of ornamentation in whit linen and net embroideries not only preceded laces, but were also subsequently made when laces were in their incipient

age only; but, having reached that stage, ey were not likely to stop there; and, they became popular and fashionable, e ingenious makers of them competed nongst themselves, as well as with the linen nbroiderers, to develop successive phases increased ornamental effects, which, whilst flecting those secured by other means, beme specialised in the laces. A new industry as thus started, growing simultaneously in aly and Flanders. This simultaneous growth no curious coincidence, but a natural result close artistic and commercial relations tween the two countries. The industry as iickly gave signs of life in France and ngland; and, looking back over the circumances, it may be said that an international ommunity of lace-makers rapidly came into istence. The same general styles of ornament were observed successively by the sections of this community; and sub-varieties of such styles came to be associated with localities, whence, as time went on, there were the laces peculiar to Venice, Milan, Genoa, Bruges, Brussels, Mechlin, Valenciennes, Paris, Alençon, Honiton, and the Midlands of England. By far the greater quantity of these laces were of white thread; some were made with gold and silver threads, and some with black and white silks; all, however, were made according to either the pillow and bobbin or the needle-point method. Wiry, geometric laces, as we have seen, came first; then the ornament was less severe, and more flowing, and the forms, instead of looking wiry, had much more the character of narrow-braid or tape; and the texture of such lace was rather more pliant and lissom. Then

FIG. 5.



EMBROIDERY (OTHER THAN DARNING) ON TO NET.
Early 17th century.

iere was a phase of heavy, close-textured ce, with bold scrolls, in which parts were of ised work and most elaborately wrought ith the needle. In contrast, as it were, to iese, the pillow-lace makers made laces in hich the braid and tape-like scrolls, were pened out, and set-off by intricate mesh roundings. The needle-lace makers reponded to this by also making lace of milar ornament, but with much finer mesh rounds, or grounds composed of endless exagons, and wheels and stars, &c., for hich a bewildering complexity of looping nd button-hole stitches was resorted to. ery large pieces of such laces were proUced for use as flounces, fichus, ample cuffs, nd bed curtains even. And finally, when rnamentalism had, as it were, run riot with all the quips and cranks of restless fancy, there was a speedy decline into the simplicity of lace-net grounds, spotted over with little bunches of flowers, sprays, single blossoms and spots. Hence it is, that with all these varieties of ornamentation and different textures, we see at the present day all of them counterfeited, with varying success, in the cottony machine fabrics, so that one day ladies wear things that somewhat resemble the vandyke geometric laces, the next something like the stately heavy-raised laces of Colbert's time, and the next clouds of nets, akin to the spotted fichus of Marie Antoinette.

And now, by means of my illustrations, I hope to give you some visible indication of what I have briefly described.

This is a portrait of Catherine de Medici, at

FIG. 6.

PORTRAIT, CATHERINE DE MEDICI WEARING A HIGH STANDING LINEN COLLAR, WITH CUT AND DRAWN-WORKED ORNAMENTS IN IT.
About 1539.

about the age of 20. (Fig. 6). It was painted Jean Clouet in 1539. In her high-standing s linen collar we see insertions of drawn threa work. Along its edge are little pointed orr ments, probably of button-hole stitch work.

Here on the screen is a portrait of Ma Queen of Scots, painted about 1587. Abc the edge of her cap and along the edge of h long veil are similar small pointed ornamen of thread work, probably of plaited and twist threads, or very simple bobbin lace.

This portrait of Charles of Savoy, chief the leaguers who defended Paris against Hen of Navarre, is dated 1582. His ruff is border with a narrow band of squares filled in wi circles and lines of needle-point work, whil the tiny ornamental edging to it is of dain devices, which may have been either of needl point or of plaited and twisted thread-work.

To give you a clearer idea of this lace wor I show an enlarged specimen of it. Paris the square framings and the ornaments with them are wrought with the needle, but tl vandykes are of twisted and plaited threads.

The foregoing portraits displayed lace wor in conjunction with linen, but here (Fig. 7)

FIG. 7.—PORTRAIT OF AMELIE, COUNTESS OF HAINAULT, WEARING A HIGH-STANDING VANDYKED RUFF OF GEOMETRIC PATTERNED NEEDLE POINT LACE. About 1600.

his painting, by Paul Moreelze, of Amelie, Countess of Hainault, we have a ruff made entirely of lace, of which material her dress is also trimmed. In this lady's lace you will recognise the style of those needle-point vandyke borders shown a short time back. The painting dates from about 1600.

A few years later is the portrait—painted by Vandyke, when quite a young man—of François de Bassompierre, Marshal of France. He wears a wide horizontal linen collar, trimmed with a deep border of dentated lace. The ornament of it consists of repetitions of squares, containing star forms, &c., as well as fleurs de lys. But these forms are fuller looking than the corresponding ones in the earlier lace of this geometric style, and they have more of a "tapy" appearance about them.

This fuller and "tapy" quality is more noticeable in the next portrait of Count Oxenstern, Minister to Charles the IXth of Sweden, an early 17th century Bismarck. The photograph is taken from an engraving of a painting by Mirevelt, of 1630. The collar here is turned down, and is of linen, trimmed with bobbin or pillow lace. The ornamentation indicates a change of style; it is not divided into a band and an edging of tooth shapes or scallops; it is designed to fill the entire width of the lace. Again, the "tapy" forms in it are well defined, by their being opened out, and merely held together by little bars or tyres, which cross the small spaces between the separate details.

Corresponding with this character of lace ornament is that in this specimen of actual lace which is of needle-point work, and has a "tapy" appearance. We may consequently say that this piece of lace dates from about 1630, or a little earlier.

How the gradual development of the "tapy"

FIG. 8.

TRIPLE SCALLOPED CUFF OF PILLOW-MADE "TAPY" LACE.
About 1630.

and pliant qualities in lace was accompanied by the adoption of forms constituting further departures in ornamental designs for lace may be inferred from such a specimen as this deep triple scalloped bit. (Fig. 8.) In each scallop is a sort of carnation or corn-flower blossom on a rather clumsy stalk. This sort of lace was in fashion in 1630, and in proof of this I refer you to the next slide. In this (Fig. 9) the "tapy" and pliant qualities of the lace are apparent, as well as the ornamental features, such as radiating blossoms in the scallops. The portrait, by Vandyke in 1634, is of a Prince of Savoy, Crignan. His collar consists of one entire piece of lace, and is not like earlier collars of linen trimmed with lace. It is, therefore, an indication of the assertion of lace as a fabric by itself, and independent of linen altogether.

But for some time ornamental linen work continued in its race for public favour with lace. And here is an effective painting by an artist of the school of Rubens, dated about 1639. There is a lingering suggestion of the earlier and formal scallops or points in the open work of the fichu or scarf which this lady wears. I think that this open work is not lace, but is of cut linen work. And in support of this supposition I have here some borders of cut linen work, much of which has been enriched with coloured silk and gold thread embroidery. (Fig. 10.) The ornament is composed of many well curved and continuous scrolls and floral devices, and the facility with which they could be cut out of linen, as they are, very much assisted the accurate rendering of the design. Corresponding scroll ornamentation, when adapted in lace at this period, is not quite so freely rendered, as we may judge from such a specimen as this, which is an important piece, namely, 1640 or so.

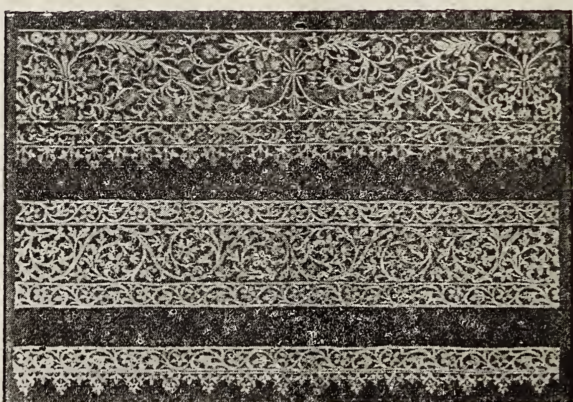
A group of Charles Ist's children, painted by Vandyke in 1639, gives an example of vandyked collars and trimmings made of "tapy" lace, and worn independently of linen. The size and varied shapes of the vandykes at this period mark a gradual change (which was taking place), in passing from pointed tooth-shape borderings to rounded scallops. And an early instance of such rounded scallops in "tapy" close-patterned lace—probably pillow lace—occurs in Rembrandt's painting, dated 1640, of a lady. The original is in the Royal Gallery at Windsor. The masterly ease with which the lace is painted in this portrait is all the more apparent when we come to compare the lace with a sample of corresponding real lace, such as we see in this next slide.

Three specimens of pillow laces are shown in Fig. 11. The first shows us the tendency to change from tooth shapes to more rounded and varied forms; the second gives us the rounded scallop, just as we saw in Rembrandt's painting; the third piece belongs to a few years later, twenty years at least. This third bit is of pillow lace. The pattern of a crowned double-headed eagle in the centre, and scrolling devices supporting it on each side, has a well-marked "tapy" effect, which makes a good contrast with the grounding of meshes in be-

FIG. 9.

PORTRAIT, BY VANDYKE (1634), OF PRINCE OF SAVOY CARIGNAN, WEARING DEEP COLLAR AND CUFFS OF PILLOW-MADE "TAPY" LACE.

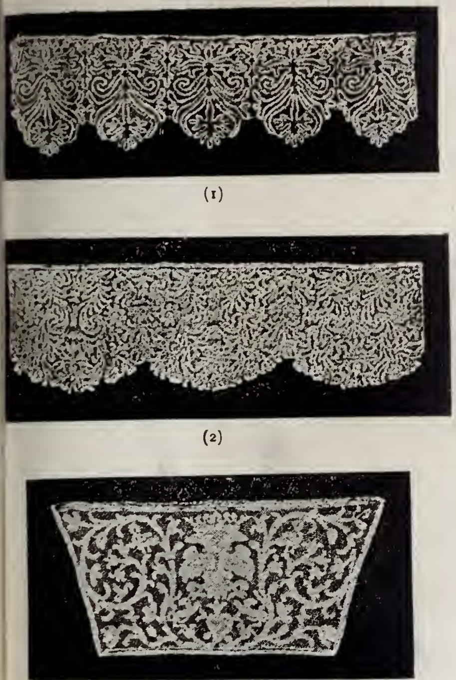
FIG. 10.



BORDERS OF CUT LINEN (TO IMITATE "TAPY" LACE), AND EMBROIDERED WITH GOLD THREAD AND COLOURED SILKS.
About 1639.

veen it. This kind of lace is soft and lissom) the touch, and, as we shall see, was made 1 much larger pieces.

Fig. 11.



(1)

(2)

(3)

Three Specimens of Pillow-Made Laces.

) About 1640. (2) About 1630 to 1640. (3) About 1650.

For instance, here are two bits of the same ind, and one of them—the larger one—is at east a foot in width. The narrow piece has a round of crossed lines, or barrings, not meshes, nd this is an indication of the way in which he lace-makers began to vary the grounds o their well-marked "tapy" patterns. The nesh-grounds are usually called *réseaux*; the round with lines sometimes placed regularly, s here, and often, later on, irregularly, and nerely to tie or link the portions of the pattern ogether are called *brides*. This is worth emembering in classifying laces; some are aces with *réseaux* or mesh grounds, and ome are laces with *brides* or bars; and these wo divisions will be found from about 1640 orwards, so that the older geometric laces, nd the close "tapy" laces are gradually eing left behind.

This portrait of Esprit Flechier, a Bishop of Nismes in the middle of the 17th century, gives cuff only of such lace, *à brides*, as we saw 1 the smaller of the last two specimens.

And in the next portrait of Francis de Montmorenci, Duke of Luxembourg, we see, indistinctly, that he wears a large lace cravat of lace *à réseau*, similar to the larger of the two specimens.

The bold "tapy" lace with the *réseau* ground was generally called "Point d'Angleterre," because such great quantities of it were made for the English market, especially in the 17th century. For years after, this name—"Point d'Angleterre" was retained for trading purposes, in respect of very differently patterned laces. It was, however, made in Flanders, where pillow-lace making flourished more than needle-made lace. The "tapy" lace, *à brides*, also of pillow make, was produced in Flanders too; but being apparently more to the taste of the Flemish, it was commonly called "Point de Flandres."

Here is a big cravat of pillow-made Point de Flandres, or "tapy" lace *à brides*.

The very considerable variety in the patterns or designs for lace which date from the middle of the 17th century is almost perplexing; and in so short a time as that at our disposal, it is impossible to do more than glance at a few specimens which tell us of this great variety.

This, now, is a portrait of a French noble, painted by Lefebure in 1666. The diagram is from an engraving of the painting. The pattern of the lace cravat is of flowers, closely arranged together, but well defined by the spaces between them, across which we can see little tyes, bars, or *brides* holding the stems and blossoms together. This is evidently a needlepoint lace, more stiff looking than the soft and lissom pillow lace.

Although the pattern is not identically the same, the likeness in style is quite marked in this piece of floral-patterned needlepoint lace, *à brides*; so that we may feel pretty certain that it is of the same date as the portrait, namely, about 1666.

Here again we seem to meet with the same class of lace, *à brides*. This is a portrait of a certain Herr Verbiest, painted in 1664 by Gonzales Coques, of Antwerp. The flowery pattern is more open than in the previous piece.

By the same artist is this portrait of Fraulein Verbiest (Fig. 12). But her lace trimming is softer looking, and is, therefore, probably of pillow lace. But the flowery style of "tapy" pattern with a *réseau* ground is still maintained. I cannot pause to enter into an argument in favour of this lace having been made at Valenciennes in preference to Mechlin, or

Bruges, or Antwerp, or Brussels. At all these places the industry was flourishing. So, too, was it at Venice, and Milan, and Genoa; so, too, was it beginning to flourish in a most marked manner in France; for a great lace-making company, under the very special patronage of the Grande Monarque, Louis XIV., had been floated by his Minister, Colbert. Laces had, according to a humorous poem of the time, got into a revolt, and all sorts were jostling each other for public favour. Alençon was vying with Venice, Havre with Ragusa Flanders with Spain, and so on. But we mus always bear in mind that it was entirely du to Colbert's diplomacy, in importing som fifteen to twenty Venetian lace workmen int France, that lace, identical in style and mak to the splendid Venetian laces, was produce in that country, although, through the more play ful fancy of the French designers and workers it came to be metamorphosed into the famou Points of Alençon and Argentan. Of the grea

FIG. 12.

PORTRAIT OF FRAULEIN VERBIEST (BY GONZALES COQUES, 1644), WEARING PILLOW-MADE LACE À RESEAUX.

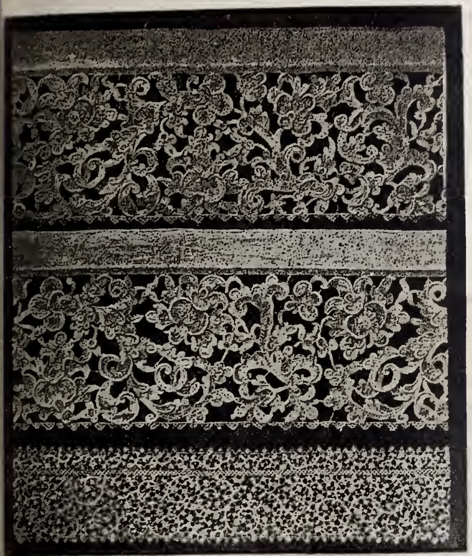
Venetian laces of the middle and end of the 17th century, I can but show a sample or two.

Here is part of large border (probably for an altar cloth or a priest's robe) which is typical of the stately and elaborate raised Venetian lace. The whole of it is of needle-point work, reducible however to the one stitch, the buttonhole stitch, that we found the simplest patterned early needlepoint laces commenced with.

Three more specimens of the same kind o work and style of design are shown in Fig. 13 The lower smaller piece is a marvel of stitchery There must be hundreds of thousands o stitches in it. Spotted about the slende graceful scrolls are little blossoms with clus ters of small loopings upon them. Some par ticularly fine examples of these raised Venetia laces are to be seen in the collection at th South Kensington Museum, from which, in

deed, most of the pieces photographed in my lantern slides have been taken.

FIG. 13.



SPECIMENS OF RAISED, RELIEF OR "ROSE POINT" VENETIAN NEEDLEPOINT LACE.

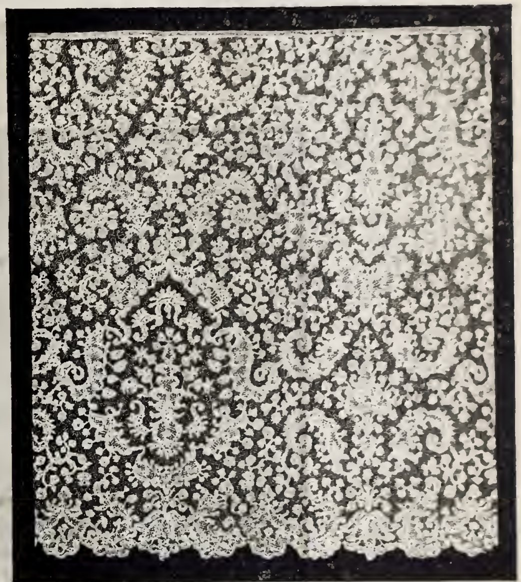
About 1660-1680.

In the portrait by Pierre Mignard, of a young princess of France, we have the front of a dress made entirely of needlepoint lace, much in the style of the Venetian scroll-raised laces. But here the scrolls and floral devices are more opened out, and in between them is a ground work of large hexagons. This sort of ground work, but on a small scale, is usually considered to be one of the principal characteristic of the Point d'Argentan, which, in a way, competed very closely with the equally famous Point d'Alençon.

Towards the end of the 17th century, lace was worn in great profusion by men as well as women; and in illustration of this I show a photograph of a portrait, painted in 1700 by Trinquesse, of the High Admiral of France, Louis Alexandre de Bourbon, son of Louis XIV., and his mistress, Madame de Montespan. The lace itself is not of any considerable distinction, as regards the ornamentation in it, though no doubt the High Admiral's cravat and shirt, which can not be well seen, were more elaborate in design than the trimmings to his coat.

Intricately patterned laces were much worn by men, especially by church dignitaries; and in this connection I may now show a photograph of part of the lace worn on his alb by Fenelon, Archbishop of Cambray. This fine piece of Flemish pillow lace, of the end of the 17th century, was presented to his Grace by Madame de Maintenon, the Veuve Scarron, whose fascinations so greatly swayed Louis XIV. The design for such a piece as this was probably made by ornamentists of such standing as Le Brun or Berain, and the lace made perhaps at Bruges or Brussels. Kindred in make and design, is such a flounce with *réseau* ground as this. (Fig. 14.)

FIG. 14.



DEEP FLOUNCE OR TRIMMING FOR A PRIEST'S ALB.

Pillow-made lace from Bruges or Brussels.
About 1680-90.

The fanciful conceits of designers of ornament for lace at this time are most remarkable, and, for the most part, have little æsthetical relation to the materials in which they took shape ultimately. At the same time, they were arranged in such a manner as to produce, when seriously regarded, well - balanced fritterings of incongruous objects or details, suited to the sort of frivolity, in most things, which delighted the fashionables of the day. For instance, let us quickly examine the details in this portion of a lace cravat. They are all carefully arranged to secure balance of pattern. In the centre is a sort of canopy, beneath which is a dancing lady. To her right and left, and below her, is a pair of corresponding little beings, also tripping. At the lower corners of

the piece are palm trees, and by the side of each is either a seated lady, possibly playing some musical instrument, or a gentleman in high peruque certainly playing a violoncello or a viol da gamba. Heaps of other devices are scattered about, and all are connected together by small tyes or *brides*. The entire design is almost like a transformation scene at pantomime or ballet. From the costume of the figures we could fix a period, if we could not, as we can, from the style of this frolicsome ornamentation, as well as well as from its use in a cravat. The make of the lace with its *brides*, and the enrichment of the larger forms, fillings in of fanciful ornaments, *modes* as they are termed, tell us its date, and we therefore know it to be of the early 18th century.

In corroboration of this let us look at portrait of the comic poet, Destouches, painted by Dubuisson about 1720. His cravat is such lace as we have been looking at—only is in folds—and if we could but undo it and flatten it out we should be almost sure to find in it many such fantastic figures and details as we saw in the last slide.

Rather more stately, but still very busy with its curls and twirls of imaginative leaves and flowers intermingled with stoutly constructed rococo framework, is the design of this fine flounce with its formal ground of small hexagonal meshes. (Fig. 15.) All this is of needlepoint lace—and is probably a grand specimen of Point d'Argentan. Such big pieces were sometimes called Point de France —the glorification of the Country in such a case superseding that of the little Norman town.

FIG. 15.

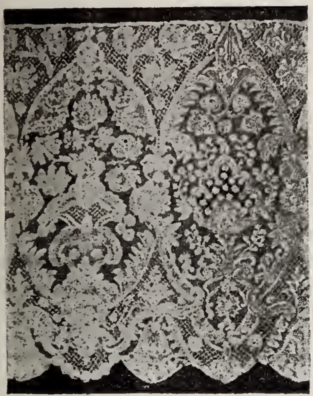
NEEDLEPOINT LACE FLOUNCE OF THE EARLY PART OF THE 18TH CENTURY.
Probably of French design and make.

Charles de Vintimille, Duke of St. Cloud and Archbishop of Paris, in 1730, is evidently wearing such a flounce as the trimming to his alb, which falls over his lap. But the styles of ornamental design were becoming exhausted. The fanciful designing, of which we have seen a specimen or two, was succeeded by a style in which a realistic imitation of flowers played the principal part.

And here is a wide Brussels pillow-lace flounce, in which, I think, you will see a number of blossoms and leaves which are closer imitations of natural forms than the previous conventionalised and imaginative details could pretend to be. (Fig. 16.) I think it may be accepted, as a rule, that close imitations of things as they look, cannot be successfully used for ornament. Ornament implies the observance of conditions in designing. Realistic imitation implies the endeavour to accurately counterfeit what is seen. It is, therefore, not an arbitrary arrangement of lines and forms, made specially with a view to ornament. This, however, is a subject which is much too extensive to be discussed now.

suffice it to say that when one sees a marked tendency to give flowers and leaves and sprays,

Fig. 16.



Flounce of Brussels Pillow-Made Lace, of Floral Design.
About 1730-50.

&c., a natural look, in lace, such lace is sure to be of a comparatively late period, that is to say, of a period about from 1730 to 1780.

We shall note this tendency in these three lace lappets, in all of which flowers and leaves or sprays are the essential decorative features. The first lappet is of Brussels pillow lace, and the chief means by which we know it is Brussels, is the fine groundwork of meshes. For a similar reason we know that the third lappet is of Mechlin make; and if we had a magnifying glass to examine the peculiar twisting and plaiting of the threads forming the meshes of these two lappets, we should perceive the difference between them. Again, you would find in the Mechlin lappet a fine thread line running round all the details, and that in conjunction with the special make of the meshes is a sure mark of Mechlin lace. If the outline were omitted, then we might be led to think that the lace was from Valenciennes. But if it were from Valenciennes, then the meshes would be differently plaited and twisted. The design might remain the same, whence we may conclude, and rightly, that designs were interchanged between different places. The interchanging and imitation of designs were most frequent, especially between Valenciennes and Mechlin, between Brussels and Alençon and Argentan, between Honiton and Brussels, and elsewhere. So that although design may be the means for fixing the date of lace, it is not a safe guide for discovering the place where the lace was made. The centre lappet is of needlepoint lace, and was made either at Alençon or Argentan. A distinctive feature of both these makes of lace is the pronounced and slightly raised outline to the various details of the designs in them. Another feature is the insertion of little enrichments or *modes;*

Fig. 17.

Brussels Pillow-Made Lace.
About 1780 to 1790.

and another feature, one generally thought to be special to Argentan, and one I have already mentioned, is the ground of honeycomb meshes, each of which is worked with close-lying button-hole stitches. How later lace patterns became altogether less elaborate and lighter in effect may be judged from the next two slides.

This (Fig. 17) is a piece of Brussels lace of the end of the 18th century, and you will notice that the same details are repeated several times. They are much less intricate, and much less important in shape and construction, than those of twenty or thirty years earlier. Still the specimen is typical of the more involved styles of designs that

were being used for laces at the end of the 18th century.

The then prevalent fashion in laces did not exact such ornamental elaboration or size of laces as had distinguished the immediately preceding period. Such pieces as these two specimens of Mechlin lace trimming would be used for sleeves and narrow flouncings. The design of the sprays and blossoms in them dces not rise to any height in imagination on the part of the designer, whilst the general ornamental effect depends upon the orderly repetition and arrangement of the same details over and over again.

How such modest filmy laces were worn, as a softening contrast to stiffer glistening silk and satin, may be seen in this portrait of Queen Christina, of Bohemia, produced about 1780.

Ample scarves and fully trimmed cloaks and doublets were no longer worn by men; and in illustration of the diminishing use of lace by them, I show a portrait by Drouais of Turgot, one of the many successive ministers of Louis XVI., 1778. His lace is but a small ruffle or edging to his shirt-front, and its ornament is of very simple character. Turgot held office for twenty months, and lost it by proposing to replenish the Treasury by a tax on the clergy, the nobility, and Parliament—a proposal, as Carlyle writes, that caused "one shriek of indignation and astonishment to reverberate through all the Chateau Galleries." The French Revolution almost extinguished lace-making in France. Other countries, like Belgium and England, continued to produce hand-made laces; but the artistic genius which had so largely nourished the industry in France, and had been widely reflected through Europe, was practically extinct.

It is not for me to now refer to the subsequent revival of hand-made laces. I have attempted to indicate means for verifying the more marked types of hand-made lace, from its birth in the 16th to its decline in the 18th century. That period has clearly provided us with a rich legacy of beautiful and various work, together with a knowledge of how cultured taste and demand exercised their influence upon lace-making. If women of the present day make complete use of this legacy, much can be done towards releasing the industry of lace-making by hand from the depressing conditions with which it has undoubtedly struggled for a considerable part of this century.

In conclusion, I thank you cordially for th interest and attention with which you have s kindly listened to my lectures upon "Mea for Verifying Ancient Embroideries an Laces."

Miscellaneous.

GERMAN COMMERCIAL MUSEUMS.

Germany entered early into the plan of commerci or trade museums, but she adopted a twofold systen M. Henri Blancheville, who was sent on a mission b the French Government to study the question c commercial museums in foreign countries, repor that Germany created at Frankfort what might b called a museum of instruction in the style of that c Brussels, at the same time she organised in differer cities of the empire depôts of samples of export prc duce (*Export Musterlager*), which are only sal agencies with branches in foreign markets. Thes are of two types, represented by the Commerci Museum at Frankfort, and the Depôt of Samples a Stuttgart. The Commercial Museum at Frankfor dates from 1885, and was founded under the auspice of the Chamber of Commece, and the patronage o the Imperial Government. Its aim is to make th manufacturers and exporters of Germany acquainte with merchandise likely to find a market in countrie beyond the seas, as well as with the price, method o packing, products, conditions of credit, to bring then face to face with articles sold by other producin nations, and to furnish them with the necessary hint on the subject. With manufactured articles are als joined the raw materials, the direct purchase of whicl might be profitable to German industry. Th museum does not pretend to collect samples of al countries. It confines itself to procuring sample from countries the least known, or novel articles fo the manufacture of which Germany may enter int competition. Thus there are to be found there goods sent by consuls from Tien-Tsin, Chefoo, Amoy, Batavia, Valparaiso, Zanzibar, Adelaide, Beirut, Merida, Saint-Jean-de-Terre, Neuve, and Bogota. Besides these, the Central Society of Commercial Geography at Berlin has given to the museum its collection of natural and manufactured products of South America. This South American collection was collected by German consuls, who forwarded a great quantity of articles imported into Montevideo, Buenos Ayres, and other places in that region by England, France, and the United States. To these sample halls is annexed a library open to the public at the hours the museum is usually open. It includes newspapers and publications having reference to export trade proceedings from Germany, as well as from foreign countries; customs tariffs, the text of treaties of commerce between different

iations, and special reports on industrial and commercial questions. There is one department which s of great interest to German manufacturers, namely, patents for inventions issued in all countries. The museum is open every day, from 9 in the morning o 1.30 and later, on special application to the lirector.

THE PRODUCTION OF LEATHER PAPER IN JAPAN.

Some years ago, the Japanese Government established an Imperial Press, which does all the printing work of the Government, from the alphabets ordered by the Minister of Public Instruction, and the postage stamps and post-cards, to the paper money, of which so much use is made in trade. One of the specialities of the establishment is the manufacture of leather papers, which has been brought to a great degree of perfection, and is so distinctly Japanese. The Japanese, taking as a pattern some of the finest European leathers, has succeeded in applying their own peculiar methods of manufacture, and fashion them according to the Japanese taste. *Papeterie* has published some details of this essentially artistic industry. The first step is the engraving of a block, consisting of a large, hard wooden cylinder, hung on to a frame, which is engraved with a knife or chisel, the worker following the model with such precision and exactitude, that the least wrong stroke is considered sufficient to spoil the whole block. When the block is ready, it is covered with moist paper, which is folded and pressed on to the mould, then taken off and hung across a bamboo to dry. When it is thoroughly dried, by exposure to the air, decoration is commenced. The paper is now spongy, and almost as absorbent as blotting paper. It is now covered with several coatings of glue, which makes the surface smooth and non-absorbent. The paper is then figured, metallised, and varnished, and the figured design then stands out, as if gilt. The Japanese have the monopoly of the best lacquer varnish. It is this lacquer varnish which gives a golden appearance to the metal, and the exact colour is at the discretion of the worker. The final operation consists in the arrangements of border patterns, by means of stencil plates. This is done by young girls, who cut out the stencils with marvellous cleverness and exactness, and wield the brush with great dexterity. The same girls touch up the border work, erasing all smudges, and filling up blank spaces, &c. The rolls of paper are then hung up again, and when dry are ready for the market. They are sent first to Yokohama, and thence all over the world. One other remarkable fact about the Japanese Imperial Press is, that it was the first experiment in Japan of industrial organisation on a large scale, at least, so far as concerns the regulating of hours of labour. Since then, labour has been organised and regulated in the same manner in the private factories of the country, to the mutual profit of the producers and the workmen employed.

THE CULTIVATION OF CHICORY IN BELGIUM.

The Belgian Government considers chicory a perfectly legitimate drink, on an equality with coffee and chocolate, for the adulteration of coffee, chicory, and chocolate, and the sale of such adulterated articles, are prohibited by law. All varieties of chicory, according to Jussieu, are indigenous to the European continent. The United States Consul at Ghent says that all these varieties may be traced back to the *chicorée sauvage* (*Cichorium intybus*) and the *chicorée endive* (*Cichorium endivia*). The former, commonly called small chicory, is especially cultivated for its leaves, which make an excellent salad. This wild chicory, so-called, is a very common perennial plant in Belgium, and is frequently cultivated in gardens. It has a fusiform and tap root; its stalk grows three feet or more in height. It is abundant along the roads and in the pasture lands of Belgium; in the gardens it develops much more, the height of the stalk often exceeding six feet, and its leaves are larger. The plant is sown in the spring, sometimes in beds, but more often along the borders. It only requires watering, and ordinary tilling and weeding. The green leaves only are ordinarily employed in medicine and domestic economy. For this purpose it is necessary to cut them from time to time, thus inducing new and more tender leaves to shoot forth; the stalk, too, must be frequently cut in order to delay as much as possible the florescence. Wild chicory is also an excellent fodder plant. Its most valuable property is its ability to grow in the worst soils, even such as are barren, chalky, or clayey. Almost all cattle eagerly hunt for the plant, and cows, which at first dislike it, rapidly become accustomed to its taste. By reason of its bitterness, it acts as a tonic, and animals who feed upon it are much less exposed to cutaneous diseases. Swine are especially fond of the roots. Among the varieties of wild chicory just described, the most important is chicory with large roots, known as "coffee chicory." It is a perennial plant, whose root, by torrefaction, acquires a bitter flavour, and an aroma, which is not unlike that of sugar converted into caramels. This is the variety which is daily increasing in commercial and industrial importance. In Belgium it largely replaces coffee in the lower ranks of society. West Flanders, in the district round Courtrai and Roulers, is its principal home. The method of its cultivation greatly resembles that of the beet. The seeds, which are very small, are sown by a hand drill, three rows at a time, during the months of April and May, and they are sown at a distance of about 15 inches apart. There are several varieties, or, rather subdivisions, of this

variety. The two chief ones are known as the "wide-leaved chichory" (*à larges feuilles*), and the "eel-headed chicory" (*frisées a têtes d'anguilles*), of which the latter is considered the best. The seed is obtained by replanting in the month of March, the old stalks being dug out during the preceding autumn. In the course of a few weeks these go to seed. Each plant gives about 300 grains of seed. Another estimate gives 530 lbs. of seed per acre. A temperate climate is required, and a vigorous soil, even slightly clayey, produces the best chicory with the heaviest roots. Sandy soils also are good, but the roots are generally lighter. The soil must be ploughed several weeks in advance. About 160,000 plants are raised per acre. A crop of from 11 to 14 tons of green roots is produced per acre. The harvest takes place in October and November. The roots must be immediately washed and dried, and then may be preserved for fifteen to eighteen months. The seeds, if put in a dry place, may be kept for seven years. The plant has no known diseases, but is subject to the attacks of a worm which eats the roots. The leaves of the plant generally grow in a small tuft, are narrow, and do not exceed ten or twelve inches in height. The roots are carrot-shaped (slightly larger), dark grey in colour on the exterior, and nearly dead white in the interior. The roots are dried on perforated racks in kilns by means of coke fires, and are then cut by machines into small pieces. These are known as cossettes, and chicory is generally exported to America in this form. Afterwards it is ground and sold in powder under the name of granulated chicory. Only very recently a Royal decree has been promulgated in Belgium declaring the essential qualities of pure chicory, requiring all packages to be legibly marked with the name, and forbidding, under heavy penalties, the sale of any adulteration as the genuine article. A similar law exists respecting coffee.

CAMPHOR AND CHINESE VEGETABLE PRODUCTS.

The reports of the British Consuls at the various ports of China and Formosa, that are now being issued from the Foreign-office, contain much that is interesting on the natural products of the countries in relation to the late war. Thus, for instance, with regard to the camphor supply, the trade in which, it was feared, would be seriously injured, even if the supply were not actually stopped. Consul Hurst, of Tainan, gives the following sketch of the business done in camphor. Last year, 1894, he says, shows a satisfactory development, 13·971 cwts. having left the port, as against 7·530 cwts. in 1893. From January to July the prices ruled rather low. In the latter month, camphor fetched, in the Hong Kong market, only £3 2s. per cwt. In August, however, on the outbreak of the war between China and Japan, there was a boom in the market, and the price rose at one time to £5 14s. per cwt. This was due to apprehensions entertained in Hong Kong of a blockade of the Formosa ports. The market quickly recovered from this abnormal figure, but prices were well maintained throughout the remainder of the year, the average price being about £4 per cwt. During the year, two more British firms (Parsees) have started in the business. There are now five foreign firms in Tainan, engaged in the camphor trade, namely, four British and one German.

In the course of the past year new districts have been opened up at Antoapo, Chan-liu-Ping, and other places in the Kagee district. An attempt was made last spring by the Kagee Magistrate to compel foreigners to convey camphor produced in Chan-liu-Ping by a circuitous road on its transit to the coast, instead of by another direct road, which shortened the journey by two days, on the plea that the former offered greater facilities for official inspection; but the Taot'ai, on being appealed to, at once admitted that foreign merchants were at liberty to convey their goods under transit pass by any route they pleased. The camphor produced is all brought down under transit pass; 71 passes were taken out in 1894, as against 57 in the previous year.

The new camphor forests are situated on the borders of savage territory, and the Chinese operatives, when cutting down trees and camphor distilling, are liable to attack by the savages. The hazardous nature of the occupation suggested to the Chinese authorities the levy of an impost, known as the "fang fei" or protection tax, on all camphor produced to pay for the maintenance of frontier guards to protect the camphor workers. Recently, owing to the exigencies of coast defence, the camphor districts have been largely denuded of troops, whose services were desired elsewhere. The continuance of the levy caused a certain amount of discontent on the part of the foreign merchants, as they said that these operations received merely nominal protection. Some outrages by savages had, at the time of writing, been reported from places in the district of Chip Chip. The camphor states had been destroyed and the operators murdered, and the savages had escaped punishment.

In Chinkiang we are told that the chief item among native imports is wood oil, obtained from *Aleurites cordata*, which is invaluable in China for preserving or varnishing woodwork, and was imported to the value of over £150,000, though it is not exported to Europe.

A branch of culture, which, it is suggested, is open to fruit growers, is the extended growth of a kind of hawthorn, whose fruit is known in the north of China as "Shan ch'a." It is described as having a very agreeable, delicate, acid taste, and can be used either stewed, dried, or made into a jelly. Though largely consumed in Chinkiang, it is more especially a native of Shang Tung and Corea, and appears to be the *Cratægus pinnatafida*, Bronge. The plant is described as a very ornamental one in spring.

Journal of the Society of Arts.

No. 2,228. Vol. XLIII.

FRIDAY, AUGUST 2, 1895.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

TECHNICAL EDUCATION.

The following letter has been addressed to e Clerks of County Councils, and to the :cretaries of the other bodies enumerated :—

"Society of Arts,
"Adelphi, London, W.C.
"July, 1895.

"Dear Sir,

"At a largely attended Conference on Tech- al Education, held at the invitation of this Society the 20th June last, the following Resolution was ssed:—

"'That, in the opinion of this meeting, it is desirable that provision should be made for examination and inspection in the subjects of instruction undertaken by Technical Instruction Committees, but not at present included in the schemes of the Science and Art Department, the City and Guilds of London Institute, and the Society of Arts, and that, with the object of giving effect to the same, this Conference recommends that a representative Committee be appointed to draw up a report and prepare recommendations upon the whole subject.'

The Council of the Society of Arts, desiring to y into effect the wishes of the Conference, have ermined to invite the following bodies to nominate esentatives on such a Committee, which it is oosed to complete by the addition of members of Society's Council:

The County Councils and County Borough Councils.
The City and Guilds of London Institute.
The Royal Agricultural Society.
The Central Chamber of Agriculture.
The National Association for the Promotion of Technical and Secondary Education.
The London Chamber of Commerce.
The Yorkshire Union of Institutes.
The Union of Lancashire and Cheshire Institutes.

I am desired to ask whether the Technical In- tion Committee of your County Council will be enough to nominate some one to serve on the Committee, which it is proposed shall be summoned to meet at a convenient date after the summer recess.

"Yours faithfully,
"Henry Trueman Wood,
"*Secretary.*"

Miscellaneous.

THE EARLY ART PRIZES OF THE SOCIETY.

Reference has frequently been made to the number of artists who received prizes from the Society during the first century of its existence, but no attempt has ever been made to enumerate them by collecting from the volumes of the "Transactions" through which the lists of awards are scattered anything like a complete list of distinguished artists who were assisted or encouraged in their youth by the prizes given by the Society of Arts. With the idea that such a list would be of considerable interest, and would afford striking testimony of the value of some of the early work of the Society, this attempt has now been made. As the list is merely a selection it can hardly hope for completeness, and doubtless some names might be mentioned which have been overlooked. Still it is thought that there are not many omissions of importance in the following article. It is believed to be fairly complete, at all events as far as refers to artists of sufficient distinction to have their names included in Redgrave's well-known Dictionary of Artists of the English school.

The founder of the Society of Arts—William Shipley—was originally a drawing master, and one of the earliest objects of the Society was the revival of the art of drawing, which was at the time of its foundation (1754) in a state of decline, by means of the offer of money prizes to boys and girls. The candidates were arranged in two classes, the first containing those under the age of fourteen, and the second those between fourteen and seventeen. An attempt was also made at the same time to interest amateurs of the upper classes in the advancement of artistic education by the somewhat curious offer of honorary premiums of gold and silver medals for drawings by young men and women under twenty-one years of age, who were respectively sons or grandsons, or daughters or granddaughters of peers and peeresses in their own right.

The first awards were made in 1755, and they were obtained by Richard Cosway, then under twelve years (but afterwards a Royal Academician and an eminent portrait painter in large and in miniature); by John Smart, aged 12 years, a fellow student with Cosway at the St. Martin's-lane Art School, and afterwards a miniature painter of distinction; by John Alexander Gresse, about the same age, and afterwards a painter of reputation, whose

father gave his name to Gresse-street, a turning on the east side of Rathbone-place; and by Miss Barbara Marsden, a flower painter of note, who afterwards married Jeremiah Meyer, R.A.

The first silver medal was presented in 1757 to Lady Louisa Grenville, for a drawing. In an anonymous account of the Society, published in 1763, we read—"Through the encouragement given by the Society to this art, drawing is become a branch of education; and as a great many of our manufactures, which depend on correctness and elegance of design, are annually exported to foreign countries, the improvement of these, which will be the result of encouraging our youth to learn this art, must, in time, prove a national advantage." At this time, the Society stood alone in the giving of prizes to artists, and the scheme was greatly extended in consequence of its success. The number of subjects was enlarged, and those to whom the premiums were offered were no longer merely boys and girls. In 1759 the subjects were increased to forty, in 1760 to fifty, and they continued still more to increase in subsequent years. In 1783 an abstract of the Rewards given in the Class of Polite Arts up to 1782 was made, from which it appears that £8,595 10s. had been awarded in money from the commencement of the Society in this one class; in addition 23 gold medals and 26 silver medals had been given as honorary awards, and 144 palettes, viz., 23 gold, 68 large silver, and 53 small silver to artists. The money was apportioned as follows:—For bas-reliefs, bronze castings, wood carvings, cameos, pastes, &c., £1,547 3s. Charts, maps, surveys, and plans, £356 10s. Drawings, etchings, engravings, mezzotints, £3,591 19s. Paintings, £3,015 18s. Improvements in crayons, water-colours, ink, &c., £84. In the first volume of the Society's "Transactions" (1783) the following observations are made upon the effects of these rewards:—"It soon became evident, from the number of candidates for premiums in the several branches of this class, that genius wanted only encouragement to shine with equal lustre in this as in other countries, and it appears that the rewards so liberally distributed by the Society have been the means of bringing forward a number of ingenious artists, and inciting individuals to such an exertion of their talents as to become an honour to the Society and to their country."

The Society's system of prizes was continued up to about 1850, when preparations for the Great Exhibition of 1851 were being made, and the work of the Society was reconstituted. During the years from the institution of the Society to that date, or nearly a century in extent, a very large number of persons were awarded premiums. Some of these drifted into other pursuits, some died early, and others did not carry out the promise of their youth; but there still remains a number of distinguished names of artists who have shed a lustre on the art of the country. A considerable number of those who carried off the Society's premiums became members of the Royal Academy, and two were presidents that distinguished body, viz., Sir Thomas Lawren and Sir Charles Locke Eastlake.

The first public exhibitions of pictures grew o of the movement for the advancement of art in t country, and this point is alluded to in the preface the first volume of the Society's "Transactions":

"The reputation acquired by several candidates, consequence of their performances remaining some time under the inspection and examination the members of the Society, before and after adju cation, occasioned the artists in general to apply an exhibition of their works, in the Society's gr room, which was accordingly complied with, a repeated annually for some years at the charge of t Society. Hence arose the annual exhibition of t rival artists, who formed themselves into separ bodies. The emulation by which each was excit helped greatly to promote the rapid improvem of the arts; and to attract the general attention the public towards their performances. And he also the royal patronage and protection they h since had the honour of obtaining, and under wh they so eminently and deservedly flourish may some measure be derived."

Of the various classes into which the so-cal "polite arts" were divided, special reference m be made to painting, architecture, sculpture, engr ing, and die sinking: in each of these divisions ma premiums were given, and some of the recipie obtained in after years a most distinguished positi

Among painters, special note must be taken George Barret, R.A., Richard Cosway, R.A., Charles West Cope, R.A., John Cotman, Nicho Dahl, A.R.A., Thomas Daniell, R.A., Willi Charles Dobson, R.A., J. Farington, R.A., Willi P. Frith, R.A., William Edward Frost, R.A., Charles Locke Eastlake, P.R.A., Frederick Good R.A., James Duffield Harding, Solomon Hart, R.A., Sir George Hayter, Thomas Hearne, James Cl Hook, R.A., Frederick Yates Hurlstone, Presid of the Society of British Artists for nearly 30 yea, George Jones, R.A., Charles Landseer, R.A., Edwin Landseer, R.A., Thomas Landseer, A.R.A., Sir Thomas Lawrence, P.R.A., Henry Le Jeu, A.R.A., Sir John Everett Millais, Bart., R.A., John H. Mortimer, A.R.A., George Mich Moser, R.A., Mary Moser, R.A., William Mulrea, R.A., Robert Edge Pine, Sir Robert Ker Port, Philip Reinagle, R.A., George Romney, William Ross, R.A., Thomas Seddon, J. Catters Smith, President of the Royal Hibernian Acaden William Westall, A.R.A., and Francis Wheatl, R.A.

Of distinguished architects may be named Rob William Billings, Edward Blore, Thomas Levert Donaldson, Pres.R.I.B.A., George Gwilt, He William Inwood, joint architect with his father St. Pancras Church, Wyatt Papworth, Sir Rob Smirke, R.A., and Lewis Vulliamy, architect Dorchester-house,

Of sculptors, special mention should be made of John Bacon, R.A., Thomas Banks, R.A., William Behnes, John Flaxman, R.A., Joseph Nollekens, R.A., Thomas Scheemakers, William Theed, R.A., and Thomas Woolner, R.A.

The number of celebrated engravers who received premiums from the Society was large, and the special patronage of the Society was extended to the revivers of the art of wood engraving. Among the most famous of these engravers were Thomas Bewick, Allen Robert Branston, Luke Clennell, George Clint, A.R.A., Samuel Cousins, R.A., Richard Earlom, Edward Finden, William Finden, Charles Grignon, Henry Hole, Michael Angelo Rooker, A.R.A., Abraham Raimbach, John Scott, Edward Scriven, William Sharp, John Keyse Sherwin, and William Woollett.

One of the tasks set themselves by the Committee of Polite Arts was the revival of the art of die-sinking in this country, and much success followed their efforts. Among those who received prizes and helped the Committee in their work were John Kirk, Nathaniel Marchant, R.A., T. Pinches, the family of Pingo, and William Wyon, R.A.

Of other rewards in connection with Fine Arts, the following require special mention:—

James Barry (R.A.), in 1798, received the gold medal and 200 guineas in consideration of his pictures in the Meeting-room.

John Boydell (1773) was awarded a gold medal for encouraging the art of engraving.

John Monro, Adelphi-terrace, the patron of Etty and many other distinguished artists, was awarded a silver medal, in 1818, for an original landscape in water colours.

Samuel More, afterwards Secretary of the Society, received, in 1763, 20 guineas for 30 different impressions of pastes resembling antique cameos and intaglios.

The Margravine of Brandenburgh, Anspach, and Bareith, &c. (previously Lady Craven), received a silver medal, in 1806, for a model in bas-relief of the late Margrave.

Although the names of famous artists have been given under the different divisions, it will be convenient to repeat in one alphabet, with the dates of the awards, a list of those who have made names which more than justified the promise of their early years. In this list, among those which are of world-wide fame, will be found some whose names are not well known at the end of the 19th century, but all were distinguished in their own day.

Bacon, John, R.A. (aged 18 years), 1759, premium of ten guineas for a figure of Peace; subsequent awards were made to him in 1761, 1764, 1765, 1772, 1776, 1777, and 1778, and in the latter year he was presented with a gold medal in recognition of his gift to the Society of the statues of Mars and Venus. An engraving of Mars by Bartolozzi, is prefixed to Vol. V. of the "Transactions," and of Venus to Vol. VII.

Banks, Thomas (R.A.), 1763, 1765, 1766, 1769, medals for bas-reliefs and life-size models. A sculptor of considerable eminence who, according to Redgrave, "takes high rank among England's sculptors."

Barret, George (R.A.), 1764, a premium of £50 for a landscape painting. Barret was one of the founders of the English water colour school of painting.

Behnes, William, 1813, silver Isis medal for an outline of the Gladiator Repellens, and in 1818 the gold Isis medal for the invention of an instrument for transferring points to marble. Behnes was originally a portrait painter, but afterwards obtained considerable fame as a sculptor, and was specially successful with his busts.

Bewick, Thomas, 1775, premium of seven guineas for an allegorical vignette on wood. The great wood-engraver must have been just out of his apprenticeship. He was born in 1753.

Biffin, Sarah, 1821, silver medal for an historical miniature. Miss Biffin although born without hands or feet, succeeded in making a name for herself as a miniaturist.

Billings, Robert William, 1836, large silver medal for a water-colour drawing of the Speaker's staircase; in 1838, a silver medal for an oil painting of a proposed restoration of the Temple Church; and in 1839 the Acton gold medallion for an analysis of the great east window of Carlisle Cathedral. He was the author of two valuable monographs on the cathedrals of Durham and Carlisle.

Blore, Edward, 1809, silver medal for an original drawing of Fotheringham Church. Blore was a famous architect in his day, and designed the front of Buckingham Palace.

Bonomi, Joseph, 1814, silver medal for bas-relief. Son of the celebrated artist, and himself an architect of some pretensions.

Branston, Allen Robert, 1806, 1807, silver palette for wood engraving. He was a wood-engraver of considerable reputation.

Brockedon, William, besides being a good painter, was an ingenious inventor. In 1823 he received the silver Isis medal for a rest for painters engaged in minute work. Brockedon was afterwards Chairman of the Committee of Polite Arts.

Buss, Robert William, 1825, silver Isis medal for portrait in oil. This artist was employed to make illustrations for *Pickwick* after the death of Seymour, and before Hablot K. Browne (Phiz) took up the work, but his engravings were not used.

Carr, Johnson, a pupil of Richard Wilson, R.A., received premiums in 1760, 1761, 1762, and 1763 for his landscape drawings. He died young at the age of 22. In Dossie's "Memoirs of Agriculture" (vol. iii. pt. 413) is the following note on this artist:— "This promising young man, at the early period of 21 years, executed drawings equal to those of the ablest masters then in this country. He died, much regretted, in 1764."

Clennell, Luke, an apprentice to Bewick, and one

of the most successful followers of that engraver, received the gold medal for a wood engraving in 1806.

Clint, George (A.R.A.), 1818, gold medal for historical engraving. This artist was successful both as a miniaturist and as a mezzotint engraver.

Cope, C. W. (R.A.), 1829, the large silver medal for a finished drawing from a statue. The portrait of the Queen and the Royal Family in the Society's meeting-room was painted by Cope.

Corbaux, Fanny, premiums in 1827, 1829, 1830, for miniatures and water-colour drawing. Miss Corbaux was an honorary member of the Society of British Artists, and a member of the Institute of Painters in Water Colours.

Corbould, George, 1806, smaller silver palette for a drawing from an antique statue. Engraver, and brother of H. Corbould.

Corbould, Henry, 1803, gold palette for an historical drawing of Mars and Bellona; also another premium in 1804. A painter and draughtsman of reputation. He prepared the drawings of the Elgin marbles for engraving.

Cosway, Richard (R.A.), premiums in 1755, 1758, 1759, 1760. This celebrated painter was born in 1740, and died in 1821.

Cotman, John, 1799, larger silver palette for a drawing. This well-known artist in oil and water-colour was about 17 when he received this award. He was born in 1782 .

Cousins, Samuel (R.A.), 1812, silver palette for a drawing of Ben Jonson; also another premium in 1813.

Dahl, Nicholas (A.R.A.), 1768, premium for landscape painting. Dahl was a scene painter at Covent Garden Theatre before his election into the Royal Academy.

Daniell, Thomas (R.A.), 1780, ten guineas for a landscape. He is chiefly known now by his fine work on "Oriental Scenery."

Dighton, Robert, portrait painter and drawing master, 1768, silver palette for a fancy head in pen and ink after Worledge.

Dighton, Denis (son of the above), 1807, silver palette for original drawing of Julius Cæsar landing in Britain; also received premiums in 1808 and 1810.

Dobson, W. C. T. (R.A.), 1842, silver medal for oil painting of the Prodigal Son.

Donaldson, Thomas Leverton, a well-known architect and P.R.I.B.A., 1814, Isis medal for original architectural design.

Earlom, Richard, premiums in 1757, 1758, 1759, 1760, 1761, 1762, 1763, 1764, 1765, 1766. He was a pupil of Cipriani, and afterwards one of the most distinguished of English engravers.

Eastlake, Charles L. (afterwards Sir Charles Eastlake, P.R.A.), 1810, silver medal for drawing of Cupid and Psyche.

Farington, Joseph (R.A.), landscape painter, received premiums in 1766, 1770, and 1771. The following note is from Dossie's "Memoirs of Agriculture (vol. iii., p. 414):—"The brothers J. a G. Farington, Richard Earlom, George Robertsc Edward Edwards, Josias Bozdell, and other al draughtsmen, have preserved to the admirers of t art, by very accurate delineations, either for engravi or for Mr. John Boydell's collection, some of t most valuable pieces in the celebrated Gallery Pictures at Houghton.''

Finden, Edward, 1810, smaller silver palette outline of Laocoon.

Finden, William, 1807, greater silver palette, drawing of the Farnese Hercules, and other premiu in 1808, 1810, and 1813. The two Findens we engravers of merit. They engraved some of Lan seer's and Wilkie's works, and produced ma illustrations for books.

Flaxman, John (R.A.), premiums in 1766, 17 1770, and gold medal in 1807, for designing t Society's medal; in the latter year, a silver medal w awarded to his sister-in-law, Miss Maria Denman, f her drawings of the medal.

Frith, W. (R.A.), 1836, large silver medal f drawing in chalk from a bust. This well-knov painter was born in 1819, so he must have been abo 17 when he received this award.

Frost, W. E. (R.A.), 1832, silver Isis medal f composition in oil in still life; 1834, gold Isis med for portrait in oil.

Gandon, James, pupil of Sir William Chambe premiums in 1757, 1758, 1759, 1760, 1763, 1764.

Goodall, Frederick (R.A.), 1838, silver medal for painting of the interior of the Thames-tunnel. M Goodall, who was born in 1822, was then about 16.

Gresse, John Alexander, painter of reputatio premiums in 1755, 1756, 1757, 1758, 1759, 17 1762.

Grignon, Charles, an engraver of reputation, wl worked for Hogarth, premiums in 1765 and 1768.

Gwilt, George, an architect of merit, but best know by his restoration of St. Saviour's Church, Soutl wark (1822-25), 1818, silver palette for origin drawing.

Hakewell, John, landscape and portrait painte premiums in 1759, 1760, 1761, 1762, 1763, 1764, 177

Harding, James Duffield, water-colour painte 1818, silver medal for original landscape.

Hart, Solomon (R.A.), 1825, silver Isis medal fo finished drawing from a statue.

Hayter (afterwards Sir), George, 1821, silver med for etching from picture by Titian. Hayter wa appointed portrait and history painter to the Quee on her accession.

Hearne, Thomas, water-colour painter, premium in 1763, 1764, 1765, 1767, 1776.

Hoare, Prince, portrait and history painter, pre mium in 1772.

Hole, Henry (pupil of Bewick), 1803, gold palett for wood engraving.

Hook, J. C. (R.A.), 1838, silver Isis medal for drawing in chalk from a statue; 1830, silver meda for two portraits in oil.

Hurlstone, Frederick Yeates, portrait and history painter, afterwards President of the Society of British Artists, premiums in 1811, 1812, 1813, 1814, and 1821.

Inwood, Henry William, architect of St. Pancras Church, 1816, silver Isis medal for original architectural view of public building.

Ireland, Samuel, engraver, premium in 1760.

Jones, George (R.A.), battle painter, premiums in 1801, 1803, and 1804.

Kirby, Sarah, daughter of Joshua Kirby, writer on perspective, afterwards Mrs. Trimmer, the once popular educational writer, premiums in 1757 and 1758 for ornamental designs.

Kirk, John, medallist, premiums in 1759, 1762, 1763.

Lambert, James, landscape painter, premiums in 1770. He was a well-known scene painter and a friend of Hogarth. He was the first president of the Incorporated Society of Artists.

Landseer, Charles (R.A.), 1814, silver palette for drawing of Laocoon.

Landseer, Edwin (afterwards Sir Edwin Landseer, R.A.), premiums for drawings of animals in 1812, 1813, 1814, and 1816.

Landseer, T. (A.R.A.), premiums in 1812 and 1813.

Lawrence, Thomas (afterwards Sir Thomas Lawrence, P.R.A.), 1782, silver palette and five guineas for copy in crayons of the Transfiguration.

Le Jeune, Henry (A.R.A.), 1834, silver palette for copy of a figure in Indian ink.

Linwood, Mary, of Leicester, 1786, silver medal "for submitting to the inspection of the Society, as examples of works of art, and of useful and elegant employment, three pieces of needlework, representing a hare, still life, and a head of King Lear." Miss Linwood opened her celebrated exhibition of embroidered pictures at the Hanover-square Rooms in 1798, and afterwards removed to Leicester-square, where her exhibition was considered one of the chief sights of London.

Marchant, Nathaniel, medallist, premiums in 1761, 1762, 1764, 1765.

Martin, William, pupil of Cipriani, 1776, gold medal for historical drawing, and twenty guineas in 1780.

Meyer, Jeremiah, miniature painter to the king, 1761, gold medal for profile likeness of George III., from memory, to be used in casting a die for the coin.

His wife, Barbara Marsden, obtained premiums in 1755, 1756, 1757, and 1758.

Millais, J. E. (now Sir John Millais, Bart., R.A.), silver Isis medal in 1839 for drawing in chalk from a bust, in 1840 for historical composition in pencil, in 1842 for historical composition in sepia, 1846 gold Isis medal for original historical painting, and 1847 gold medallion for original composition in oil. As Sir John Millais was born in 1829, his first award was obtained when he was only ten.

Mortimer, John (A.R.A.), premiums in 1759, 1760, and 1762. In 1763 he received 50 guineas for an oil painting of Edward the Confessor taking his Mother's Treasures, and 100 guineas in 1764 for St. Paul preaching to the Britons. The last picture was placed as an altar piece in the church of High Wycombe, Bucks, where the painter is buried.

Moser, George Michael (R.A.), enameller and modeller, premium in 1758.

Moser, Mary, daughter of the above and an original R.A. (afterwards Mrs. Lloyd), premiums in 1758 and 1759.

Mulready, William (R.A.), 1800, greater silver palette for drawing. Mulready was born in 1786, so he was only 14 at the date of the award. In 1848 a collection of Mulready's works was exhibited in the Society's house. He died in 1863.

Nollekens, Joseph (R.A.), the distinguished sculptor, premiums in 1759, 1760, 1761, and 1762.

Papworth, Wyatt, architect and author of the "Dictionary of Architecture," premiums in 1836 and 1838.

Pinches, T., 1836, large silver medal for an original medal die modelled from life, and another medal in 1836.

Pine, Robert Edge, history and portrait painter, one hundred guineas for an oil picture illustrating the surrender of Calais to Edward III., and one hundred guineas, in 1763, for another picture.

Pingo, Thomas, the father, engraver to the Mint, premium in 1758.

Pingo, John, eldest son, premiums in 1759, 1760, 1761, 1763, 1765.

Pingo, Lewis, another son, premiums in 1756, 1757, 1758, 1759, 1760, 1761, 1763, 1764, 1770, 1771, and 1772.

Pingo, Henry, premiums in 1756, 1758, 1759, 1760, 1761.

Pingo, Benjamin, premiums in 1765, 1766, 1769.

Pingo, Mary, premiums in 1758, 1759, 1761, 1762.

Porter (afterwards Sir), Robert Ker, "artist, soldier, author, and diplomatist" (Redgrave), 1792, lesser silver palette for an historical drawing of the Witch of Endor.

Raimbach, Abraham, engraver, 1806, gold palette for wood engraving.

Reinagle, Philip (R.A.), animal and landscape painter, premium in 1767 for drawing of the human figure from living model.

Romney, George, the celebrated portrait painter, premium of twenty guineas in 1763, for an oil picture of the death of General Wolfe, and fifty guineas, in 1765, for picture of the death of Edward the First.

Romney, John, engraver, 1806, smaller silver palette for drawing of outlines.

Rooker, Michael Angelo, (A.R.A.), water-colour painter and engraver, premiums in 1759 and 1760.

Ross, William C. (afterwards Sir William Ross, R.A., the well-known miniature painter), premiums in 1807, 1808, 1809, 1812, 1816, 1817.

Scharf, George (afterwards Sir George Scharf,

K.C.B., keeper of the National Portrait Gallery), 1836, silver Isis medal for drawing from cast of statue.

Scheemakers, Thomas, sculptor, premiums in 1765, 1766.

Schiavonetti, Lewis, engraver and pupil of Bartolozzi, 1807, silver medal set in gold for engraving of the British troops in the Bay of Aboukir.

Scott, John, engraver, 1810, gold medal for two original engravings of fox hunting.

Scriven, Edward, engraver, 1812, lesser gold medal for engraving of Gerard Douw; another premium in 1814.

Seddon, Thomas, landscape painter, 1848, silver medal and £20 for drawings of an original design for an ornamental carved sideboard. He was the son of a cabinet maker.

Sharp, William, famous engraver, premiums in 1761, 1763, and 1764.

Sherwin, John Keyse, engraver, premiums in 1769, 1772, 1774, 1775, and 1778.

Smart, John, miniaturist, premiums in 1755, 1756, 1757, and 1758.

Smirke, Robert (afterwards Sir Robert, R.A.), 1796, silver medallion for drawing of the Water-gate at York-buildings.

Smith, J. Catterson, afterwards President of the Royal Hibernian Academy, 1825, silver Isis medal for oil painting from bust.

Smith, Nathaniel, modeller, premiums in 1758, 1759, 1760, 1761, 1762.

Tassie, James, gem engraver, premium of ten guineas, in 1767, for pastes of figures, heads, &c., resembling antique onyxes.

Theed, William (R.A.), 1822, silver Isis medal for model in plaster of a single figure.

Vivares, Thomas, engraver, premiums in 1758, 1760, 1761, 1763, 1764, 1765, 1766.

Vulliamy, Lewis, architect of Dorchester-house, Park-lane, 1812, silver medal for design for a picture.

Ward, William, mezzotint engraver, 1804, lesser silver palette for drawing of Ewell Church.

Ward, William James, mezzotint engraver, 1813, silver Isis medal for pen and ink drawing of Holy Family.

Westall, William (A.R.A.), landscape painter, 1797, lesser silver palette for drawing.

Wheatley, Francis (R.A.), landscape and subject painter, premiums in 1762, 1763, 1767.

Winkles, H., 1819, Isis medal for pen and ink drawing of St. Mary's Abbey, York. He was joint author (with B. Winkles) of the valuable work on the English Cathedrals.

Woollett, William, 1759, premium for drawing of the human figure from living model. Woollett was one of the finest engravers England has produced.

Woolner, Thomas (R.A.), sculptor, 1845, silver Isis medal for original modelled design, entitled "Affection."

Wright, Richard, marine painter, premiums in 1766, 1768.

Wyon, Benjamin, seal engraver, 1818, gold medal for original medal die.

Wyon, Thomas, jun., 1810, gold Isis medal for die engraving.

Wyon, William, medallist, 1812, gold medal for medallic engraving head of Ceres; again in 1813.

THE MINT.

The twenty-fifth annual report of the Deputy-Master of the Mint for 1894, which has lately been published, contains the statistics of the work done at the Royal Mint during the past year.

Gold Coinage.—The gold received for coinage from the Bank of England was as follows:—

		£
Bullion		*Nil.*
Light gold coin (received as bullion)......		*Nil.*
Light gold coin (under provisions of the Coinage Act, 1891) nominal value:—		
Sovereigns	£2,356,000	
Half-sovereigns	1,244,000	
		3,600,000
Total		£3,600,000

Thus for two years in succession the gold received for coinage has, with the exception of a trifling amount of bullion received in January, 1893, consisted exclusively of light coin for exchange at its nominal value under the provisions of the Coinage Act, 1891. The coins considered by the Bank to have been illegally dealt with within the meaning of that Act, and purchased at their bullion value, amounted at the close of 1894 to £216,801 only, or 0·828 per cent. of the entire amount withdrawn at that date.

The total gold coinage was £5,679,906 10s., of which about one-third consisted of half-sovereigns.

Silver Coinage.—The value of the silver coin issued in 1894 was less than that in the preceding year, and fell short of the average issues of the ten years, 1884-93, by £75,106. The number and value of silver coins struck was as follows:—

	Pieces.	Value. £	s.	d.
1893....	21,469,117	1,089,707	15	6
1894....	14,701,018	827,034	10	2

The denominations of the coins issued for circulation in the United Kingdom, of the value of £778,975 in 1893, and £707,000 in 1894, as shown in the above Table, were as follows:—

	1893. £	1894. £
Crowns	90,600	68,650
Half-crowns	193,000	165,600
Florins	100,000	141,500
Shillings	253,900	230,200
Sixpences	121,400	85,800
Threepences	20,075	15,650
Total	£778,975	£707,400

Bronze Coinage.—The gradual reduction in the emand for bronze coin, which has been observable uring several recent years, is shown to have connued during 1894, when the total issues fell to 33,485, having been £46,664 in the preceding year, nd an average of £58,395 during the ten years 885-94. The number and value of bronze coins truck was—

	Pieces.		Value. £	s.	d.
1893....	19,295,401	..	53,135	7	5
1894....	8,047,857	..	22,360	5	2

'he amount of bronze coin issued was—

	1893. £	1894. £
To United Kingdom ..	44,879	32,575
To Colonies	1,735	760
To Treasury chests	50	150
Total........	£46,664	£33,485

The marked fall which is shown to have occurred n the issues to the United Kingdom arises, as in ormer years, from the fact that during long periods, nd indeed during the entire year so far as concerns ertain districts, applicants for new coin have been eferred, both in London and many parts of the rovinces, to bankers and others who had reported o the Mint that they held stocks in excess of their equirements. As evidence of the abundance of ronze coin in the metropolitan district at the resent time, it may be mentioned that, whereas he average annual issues in London during the receding ten years have amounted to £16,493, or bout two-fifths of the corresponding issues, £39,564, o the rest of the United Kingdom, in 1894 the netropolitan applicants only received £8,850, while he issues to the provinces amounted to £28,725. The principal districts in which the issue was susended during the year were, in addition to the netropolis, Birmingham, Bristol, Derby, Glasgow, Newcastle, and Preston.

One of chief pieces of work at the Mint during the ast year was the coining of a new British dollar. Reference has been made in several former reports to proposal emanating from the trading communities f the Straits Settlements and Hong Kong, that a pecial dollar for use in the East should be struck in his country, and on each occasion the predecessor of the present Deputy-Master found himelf unable to recommend the adoption of that roposal, primarily on the ground that, under the nost favourable conditions, it would be impossible o lay down such dollars in the above-mentioned olonies at a price which would enable them to comete with the Mexican dollar. Their Lordships were leased to determine, therefore, that it was not desirble to comply with the applications received from Hong Kong in 1874 and 1877, or with that from the Straits Settlements in 1887, Early in the year 1894 he Hong Kong Chamber of Commerce again brought he subject forward, being led to do so by the scarcity of Mexican dollars, consequent on the fall which had taken place in the value of silver, and the threatened currency famine in the colony. Their proposal was strongly supported by bankers and others having commercial relations with the Straits Settlements as well as with Hong Kong, and by the several Chambers of Commerce concerned, including that of London. The Secretary of State for the Colonies, therefore, after consultation with the Colonial Currency Committee, which he had requested to advise him on questions connected with the currency of Eastern colonies, recommended the suggestion to their Lordships' favourable consideration, and, towards the close of last year, the necessary steps were taken for preparing designs for the new coin for submission to Her Majesty for approval. In view of the special character of the proposed dollar, which will, it is hoped, command an extended circulation in countries not under the British Crown, and of the well-known objection of many Eastern nations to alterations being introduced into the designs of coins which pass among them as currency, it was determined that the obverse should bear a representation of Britannia, to mark the British character of the coin, with the words, "One dollar" and the date, the reverse bearing the denomination in Chinese and Malay characters. In the illustration which accompanies the report, the obverse and reverse designs adopted for the new coin are shown enlarged and in actual size, the Chinese characters for "one dollar" occupying the upper and lower quarters of the scroll, while the corresponding Malay characters are to the right and left.

The Deputy-Master (Mr. Horace Seymour) concludes his report with a reference to the loss sustained by the Department in consequence of the retirement of Sir Charles Fremantle, who occupied the position of Deputy-Master and Comptroller of the Mint, from 1868 until September last. The appendix to the report contains various memorandums from the Superintendent of the Operative Department, and the Chemist and Assayer (Professor Roberts-Austen), who describes the scientific researches at the Mint, reports of the trials of the Pyx, &c.

ITALIAN COTTON INDUSTRY.

The following particulars, based on a report by Consul-General Sir Dominic Colnaghi, are taken from the *Board of Trade Journal*:—

The cultivation of cotton in Italy, which, in 1864, occupied 88,000 hectares (hectare = 2·47 acres), and yielded a gross produce of 623,000 quintals (quintal = 220·4 lbs.), equal to 250,000 quintals of raw cotton, had decreased, in 1886, to about 16,000 hectares, with a gross product of 133,000 quintals, or 53,000 quintals net. At the present time the cultivation is almost entirely abandoned.

The imports of raw cotton into Italy have shown a steady rise from 195,618 quintals in 1876 to 813,169 quintals in 1893 (exports deducted).

This evidence of the increase of the cotton manu-

facture in Italy is confirmed by the statistics of the gradually decreasing imports and increasing exports of some of the principal categories of yarns and tissues.

With regard to the diminution of the imports, no doubt the rise in the protective duties, established by successive tariffs since 1878, has not been without its effect. To this may be added the industrial, agricultural, and financial crisis through which Italy, like other countries, has passed and is passing. Still the regular diminution of the imports on certain important classes of goods from which, however, mixed tissues must be excepted, coupled with the rise in the imports of raw material, points to a steady progress of the cotton manufacture in this country. This may further be deduced from the increasing exports, though these for various articles are at present merely tentative, and are important chiefly for plain tissues, coloured or dyed. There is also a sensible increase in the exports of sewn articles.

The Italian mills are increasing in size, steam power is supplementing the water supply where required, they are fitted with all the modern improvements, and are, in many instances, lighted by electricity. With the progress of the industry the spinners have acquired greater technical ability, and the number of hands employed per spindle is gradually decreasing.

The qualities of cotton yarns, chiefly imported the year 1893 were as follows :—

Description.	French Numbers	English Numbers.	Quantiti Importec
			Quintals
Unbleached, singles...	10 to 50	11 to 59	2,354
Bleached, singles	20 „ 30	23 „ 35	127
Dyed, singles	10 „ 30	11 „ 35	242
Unbleached, twists ...	10 „ 40	11 „ 47	1,663
	41 „ 60	48 „ 71	883
Bleached, twists.........	10 „ 30	11 „ 35	903
Dyed	10 „ 30	11 „ 35	522
	30 „ 60	36 „ 71	242
	above 60	above 71	103
Other numbers	—	—	1,074

The principal importing countries were Gre Britain, Switzerland, and Germany.

The exports, chiefly dyed yarns, singles and twist were sent for the most part to the Argentine R public and the Levant. The numbers of the yar are not given in the Custom-house returns.

Sewing cotton, on reels, in balls, and the like, pr pared for retail sale, was imported chiefly from Gre Britain.

Description.	Weight in kilos. per 100 square metres.	Qualities.	Quantity.	Balance in light goods.
Tissues, plain—			Quintals.	Quintals.
Unbleached......................................	7 to 13	Medium	10,937	680
	13 and above	Heavy	755	
Bleached	13 and above	Heavy	7,682	503
	7 to 13	Medium	3,021	
Coloured or dyed	7 to 13	Heavy	5,351	238
	13 and above	Heavy	2,281	
Printed	7 to 13	Medium	14,335	311
	13 and above	Heavy	3,361	

Of these yarns, which, in the Italian Customs-house returns, refer to dyed cotton yarns mixed with a little wool, the total imports were 535 quintals, of which 501 came from Germany.

The imports of plain tissues into Italy are tending steadily to decrease. In 1889 they amounted to 72,257 quintals; in 1893, they had fallen to 49,545 quintals.

Great Britain still hold the first place in all the imports of plain tissues with 30,547 quintals, followed at some distance by Germany and then Switzerland. With regard to the exports, the chief place is taken by coloured or dyed tissues, the export of which shows a continually-increasing importance. In 1893 it had attained to 25,258 quintals, of which 18,922 were sent to the Argentine Republic, the principal r cipient of all the Italian exports of plain tissue with the exception of unbleached. Of other cou tries may be mentioned Turkey in Europe (2,8 quintals), Brazil (1,253 quintals), and Uruguay (6 quintals).

The amount of raw cotton imported into Italy the year 1867 was only 80,575 quintals; in 1893 tl figure had reached 813,169 quintals.

The marked progress in the cotton indust appears, then, to have been continuous for son years; evidence of this fact is afforded in tl following comparison of the official statistics pu lished for the year 1876, with those for the ye 1893:—

	Number. 1876.	1893.
Number of mills	647	532
Total number of hands	53,484	87,690
Number of spindles	764,862	1,336,418
Looms—		
Power	13,517	36,863
Common hand	14,300	9,868
Jacquard		465
	27,817	47,196
Motive power—		
Steam, horse-power	2,990	18,480
Hydraulic, horse-power	9,703	27,545

Three-fourths of the Italian mills still work day and night, therefore the actual number of spindles, as noted in the Table for 1893, may be deemed equal, in round numbers, to 2,300,000. As the larger number of mills are, however, worked by hydraulic power, which is subject to considerable variations, their potentiality cannot be estimated at the same rate as that of the foreign mills, almost exclusively worked by steam power.

The principal centres of the cotton industry are in Lombardy, Piedmont, and Liguria, followed by Venetia, Tuscany, and Campania. The provinces in which the industry is chiefly exercised are, for Lombardy, Milan, Bergamo, and Como; for Piedmont—Turin and Novara; for Liguria—Genoa; for Venetia—Udine; for Tuscany—Pisa; and for Campania—Salerno.

The numeration of cotton yarns varies in different countries according to the basis on which it is founded. In the English system the number shows the number of hanks weighing 1 lb. English of 454 grams. The French have selected, as their basis of enumeration, the number of metres that weigh ½ gram.

In the Italian mills the English numeration is generally followed, while in the Italian Custom-house returns the French system is adopted.

To meet the wants of the home market, the principal production of the Indian spinning mills has been hitherto in low numbers. Now, however, a great number of water No. 38 and tram No. 44 of American and Mako cotton are being spun. Fine yarns are still produced only to a very limited extent, though Nos. 40, 50, and 60 have been made for some years by several spinners, while, at Turin, a mill has recently been erected, mounted with 20,000 spindles for spinning fine yarns, Nos. 50 to 120, these last, with several of the other numbers, being made into twists of two or more threads for making cotton, lace, tulle, &c., and also for the weft of silk ribands, instead of using pure silk. It is said that a first-class article is turned out.

As for the spinning so for the weaving industry, a satisfactory progress is to be noted, especially in recent years.

The number of looms was calculated, in 1868, at 86,000. At that date they were all hand looms, worked in the weavers' homes. In 1876 the number of power looms in the different factories amounted to 13,517; in 1893 they had increased to 36,863.

The cotton tissues hitherto manufactured in Italy are of the coarser kinds, the fine tissues having been almost entirely imported, Great Britain still holding the first place in this category.

In comparison with the spinning mills, there are but few weaving mills in which the work is prolonged during the night.

The following Table shows approximately the general average annual value of the cotton tissues produced in Italy:—

Description.	Number of Looms.	Average Daily Production per Loom.	Average No. of Working Days per Annum.	Total Annual Production of Tissues.	Average Cost Price per Metre.	Total Value of Tissues.
		Metres.		Metres.	Lire. c.	Lire.
Hand, simple	9,868	10	130	12,828,400	0 10	1,282,840
,, Jacquard	465	6	250	697,500	0 40	279,000
Power	36,863	35	290	374,159,450	0 54	202,046,103
Total	47,196	—	—	387,685,350	—	203,607,943

On the whole it may be noted that, although Italian cotton goods in general cannot as yet be considered equal to English manufactures, nor perhaps able to hold their own without the help of protective duties, there is no doubt but that, both in quality and workmanship, they have greatly improved of late years. The tissues are strong, durable, and fairly woven. Italian yarns are stated to be very good and equal to the foreign production.

Sir Dominic Colnaghi, in his report, adds that as the official statement prepared by the Ministry of Agriculture Industry and Commerce at Rome, of which he has made use, is the first general report on the cotton industry that has been drawn up since 1878, Signor Bodio, Director-General of Statistics, wishes him to state that the figures it contains are still under revision and subject to further correction.

THE MANUFACTURE OF VIOLIN STRINGS IN SAXONY.

It is generally supposed, though it must remain a matter of conjecture, owing to the lack of reliable information on this point, that the manufacture of gut strings (the name of catgut is misleading, for all the "catgut," so-called, sold in the market for stringing musical instruments and for medical purpurposes comes from the sheep) was transplanted to the town of Markneukirchen, through immigrating Protestant Bohemians during, or soon after, the Thirty Years' War (1618–1648). Some men of Markneukirchen had acquired the trade and bequeathed to their sons the secret, for such it was considered, especially the knowledge of the component parts of the lye used to bleach the sheep-gut. The United States Consular Agent at Markneukirchen, says that in the year 1777 the union of string makers was founded, and, in 1781, had a membership of 13, which increased to 36 in 1793. To join the union the applicant had to perform the chief work without the least assistance, under strict surveillance of one or more of the union's members. The work had to elicit the entire satisfaction of the representative men of the union, and consisted of one bundle (thirty pieces) of E strings; half a bundle (fifteen pieces) of D strings; half a bundle of A strings, and one complete set wherewith to string a violone (the largest instrument of the bass-viol kind). If this task was finished satisfactorily, the workman was accepted as a brother member, and his employer was, by contract, under obligation to give him a good recipe for making a bleaching lye. This was, therefore, given to him, but, as a matter of fact, none of the masters parted with their individual secret, only leaving it, after death, to their sons or next of kin. All inquiries made on this subject lead one to suppose that, at present, potassa lye is generally used. About seventy-five years ago, Markneukirchen used Bohemian and Bavarian sheep gut, but, later on, Prussia furnished a fair supply. Within the last decade, material for making strings has been obtained from England, Russia, Denmark, Spain, Bulgaria, Turkey, Java, Damascus, and Jerusalem. The intestine needed for a musical string must be from a lamb born in the spring and slaughtered not later than October or November of the same year; those from the older sheep can be used only to make bass strings or for other minor purposes. The prices vary in accordance with the time of year at which the sheep was killed. In the manufacture of strings, the dried intestines are first placed in earthen vats containing a potassa lye, where they are left for 24 hours. After the lapse of this time they are sufficiently soaked to permit unravelling, for, in spite of the bath, they still adhere. They are then placed in a fresh potassa lye — the strength of the lye must be regulated according to the age of the sheep when killed, and must be weaker for the intestine from the spring amb than for that from the six to nine months old sheep. For eight days in succession the bath is daily renewed without varying the strength of the lye. Beginning from the second day, the intestines undergo, at various times of each day, the most thorough cleaning by girls armed with the "sliming" or cleaning iron. The intestine is drawn between the first finger, covered by a guttapercha glove, and the thumb of the left hand, the sliming iron or ring being held with the thumb. By this act are removed the external (peritoneal) and mucous membranes, leaving only the muscular or fibrous membrane used to make a string. After the above described proceeding has been attended to daily for three consecutive days, the intestine is sufficiently fluid to be split in two parts, by being drawn across a blade of a sharpness exceeding that of a razor, firmly fastened to a handle, which in turn is affixed to an upright. The sliming is now continued; this was formerly done by hand, but is now done by means of a machine. Here the intestine is drawn over five upright blades, above which, securely fastened, is a 25 lb. gutta-percha weight, that bears down on the intestine with the required pressure. Four days more of this proceeding suffice to get the intestine ready for the workman, experienced in sorting the parts according to quality, thickness, and length. It must be noted that there are two qualities resulting from one gut; for, on being split in two, the adhesive (inner) part is not even or smooth, and can therefore be used only for the inferior qualities. The number of parts needed for any one string depends upon the thickness of the intestine. For instance, to make an E string from Russian gut, four to six parts are necessary; from English sheep-gut, three to four parts, because the Russian is finer than the English gut; at least three parts are taken to make a string. A violin A string is double the size of an E string; therefore, parts of double thickness are used, but the same number of parts that are required for an E string. Again, a D string, being three times as thick as the E string, 15 to 20 parts of the intestines from the spring lamb are used when a fine quality D is desired; for, as already pointed out, the intestine from the sheep killed in its earliest stage is too weak for an E string, but answers very well where a large number of parts are joined. The bass strings are made from the unsplit fibrous membrane; 30 to 50 entire (unsplit) parts are taken for a G, 45 to 75 parts for a D, and 60 to 90 parts for an A bass string. The following processes up to the time when the finished strings are placed in the sulphuring chamber must be performed on one and the same day to prevent putrefaction. The parts selected to make one string are attached at both ends to hempen loops; one of these is fastened to one of two hooks in the centre of a little wheel, stationed at one end of the inner part of a frame, the intestinal parts twisted round a fixed peg at the other end of the frame opposite the wheel, and the second loop

brought back to the wheel to be attached to the second hook in the centre of the wheel. The latter is now rapidly revolved by a connecting multiplying fly-wheel, and the parts thus twisted into a string. The moisture brought to the surface by the twisting is removed, and the strings are taken from the frame and placed in an air-tight sulphuring receptacle, where they are left over night. On the following morning they are exposed to the air, which furthers the bleaching process, till nearly dry, when they are again slightly moistened and replaced in the sulphur bath. This operation lasts from 8 to 10 days, the length of time depending on the weather. The best and whitest string, aside from the result of the sulphurous acid gases, is that which has had frequent exposure to the air in clean, balmy weather. Excessive bleaching by means of sulphur heightens the whiteness at the expense of the quality. The strings must never be exposed to the sun if the heat resulting exceeds a moderate temperature of 75° Fahr. After the bleaching, the string is subjected to a rubbing with pumice-stone, to bring it down to the correct size, which removes, at the same time, any existing inequalities. The requisite polish is mainly due to frequent wipings with olive oil. Following this, they are again left to dry in the air, to be there cut, rolled, and assorted according to colour. Thirty strings of the same size and whiteness are made up into a bundle. From the time that the dried intestine is first placed in the lye to the time when the finished strings are assorted and ready for the market, 18 to 20 days elapse. During this period, not a day passes without the intestine or the partly finished string being subjected to manipulation of some sort. It is generally supposed that a musical string loses both its colour and quality, if kept in stock for a comparatively short period, but, while the colour is impaired in the course of time, the quality does not deteriorate, provided the strings are stored in hermetically closed cases, in an even and dry atmosphere.

Notes on Books.

Text-books of Science, Telegraphy: By W. H. Preece, C.B., and Sir J. Sivewright, K.C.M.G. Eleventh Edition. London: Longmans, Green, and Co. 1895.

The first edition of this well-known text-book was issued in 1876, and a comparison of the volume in its earliest and in its present shape shows in rather a striking manner how marvellous has been the progress of telegraphy during the past eighteen years. The book has grown from 300 to over 400 pages, and contains 265 instead of 161 figures, but the alterations in its contents is not merely by the addition of fresh matter. The changed condition of the science has necessitated a complete change in the arrangements of the book which appears practically to have been rewritten. In 1876 the telephone was unknown; it now requires a chapter to itself. In 1876 duplex telegraphy was described in a chapter devoted to "Special Telegraphy," and this same chapter included automatic and submarine telegraphy. Now, duplex, quadruplex, and multiplex have each a chapter to themselves, as have, also, automatic telegraphy, submarine telegraphy, and repeaters. There were, originally, two chapters on "construction," now there are three, and the single chapter on testing has been expanded into two. The final chapter in the original book on "Commercial Telegraphy," in which an account was given of the routine of an English telegraph office, has been omitted altogether. There have been, of course, great changes in many of the instruments, and there are some absolute novelties—such as the secondary battery, though the part it plays in telegraphy is not an important one. The use of telegraphic currents does not appear to be mentioned, though—at all events, in the United States—such an application is of sufficient importance to justify a reference.

Architecture for General Readers: a Short Treatise on the Principles and Motives of Architectural Design, with a Historical Sketch. By H. Heathcote Statham, F.R.I.B.A., Editor of the *Builder*. London: Chapman and Hall. 1895.

Architecture is an art full of technical details, and the general reader is often driven from its study on this account. At the same time it is the one art that opens up to the student the history of the human race, because the biography of humanity is written in its monuments, and therefore it is the one art of which the general reader ought to have some knowledge. The architect as a rule resents the criticism of the outsider, and yet although technical details are only to be judged by the educated architect, the layman who has cultivated his taste may surely express his opinion on the general appropriateness of the design of a building. It must be remembered that although Thomas Rickman afterwards acted as an architect he was a layman when he laid down the laws of Gothic architecture in his epoch-making "Attempt to discriminate the styles of architecture in England." It is quite possible for a building to be correct in all its details, and yet to be ineffective in its general outline, while many distinguished architects with a genius for effect have been faulty in details. Under these circumstances, it must be conceded that Mr. Statham has done well in explaining to the general reader the principles and motives which must govern the designs of the architect. The author urges the need of expression, and the relation of design to structure, pointing out how important is the organic unity of a building. In dealing with the typical forms of Egyptian, Greek, and Gothic temples, he describes the Egyptian type as that of Mystery, the Greek type as that of Rationalism, and the Gothic type as that of Aspiration. In the first chapter the

author deals with the influence of roofing, in the second with trabeated architecture, and in the third with arcuated architecture; in the second chapter the blunder of the Romans and the architects of the Renaissance in making the arch spring from the entablature rather than from the column itself is pointed out, and described by the author as the most absurd and illogical blunder ever made in architecture. With regard to these styles, it is a remarkable fact, that although classical architecture is usually classed as the exact opposite of the Gothic, the latter has been evolved from the former in a manner that is clearly defined, and is incontestable in its historical sequence. First, we have the Romanesque (early = Saxon, later = Norman), where the round arch of the Norman church-builders is merely an adaptation of the Roman arch; then the massive and solid column of the early Norman becomes elongated and divided out, so as to form later on (when the pointed arch was evolved from the round arch) the groundwork of the Early English style; then the Gothic went on elaborating itself, until the time when the Rennaissance in Tudor times debased it so far, that it died away, only to become again triumphant by reason of the great revival in the present century. The last chapter of the first part is devoted to the consideration of architecture in relation to cities and landscapes. The second part deals with the historical portion of the subject. The book is fully illustrated.

A SCIENTIFIC SOLUTION OF THE MONEY QUESTION. By Arthur Kitson. Boston (U.S.): Arena Publishing Company. 1895.

The author opposes the received opinions on political economy, and finds the only cure for modern evils in free trade in money. He considers that "the desire to acquire and hoard money is a perversion of the natural use of things. Money is made for use for exchange, to transfer, to spend as currency, to be kept running, moving, not stationary. Money is not a standard of value, nor a measure of value. It expresses value, it registers purchasing power." The author divides his subject as follows:—1. Economics and Ethics. 2. The Factors of Production. 3. Wealth. 4. Exchange Barter. 5. Value. 6. Standard of Value. 7. Purchasing Power. 8. Money. 9. Gresham's Law. 10. Material Existence of Money. 11. Price. 12. Cause of General Rise and Fall in Prices. He claims novelty and originality for his suggestion in this chapter of "the invariable ideal unit of purchasing power." 13. Money Supply and Demand. 14. Currency. 15. Credit. 16. Insurance of Money. 17. Usury. 18. The last chapter contains the author's statement of his solution of the question, which he has dealt with from the scientific standpoint, and he gives the solution in these words:—"It will be found in free exchanges—exchange freed from tariffs and taxes of every description, unobstructed by custom houses and licensed banking houses, by law makers and usurers." The Appendix is devoted to Monometalism *versus* Bimetalism. The author's main contention is, that money is not a commodity, but merely a medium of exchange.

General Notes.

PETROLEUM IN GALICIA.—The Austrian Minister of Finance, according to *Le Monde Economique*, reports thatduring late years the production of petroleum in Galicia has increased by 600,000 quintals yearly, while the importation of Russian petroleum into the dual State has diminished by 400,000 quintals, and that of the United States has been reduced to 80,000. The excise on petroleum has increased by 2,000,000 florins yearly. A company, formed at Fiume, is engaged in active prospecting for petroleum in the Carpathians, and also in Croatia, where enormously rich springs are found.

BERLIN INDUSTRIAL EXHIBITION.—Information has been received from the Foreign Office, through the Science and Art Department, respecting an Industrial Exhibition, to be held at Berlin from May to October, 1896. The Exhibition will be classified under 24 groups, as follows:—I. Textiles. II. Dress and Costume. III. Architecture and Engraving. IV. Wood Industry. V. Porcelain and Glass. VI. Hardware and Fancy Goods. VII. Metal Industry. VIII. Graphic and Decorative Arts. IX. Chemistry. X. Food. XI. Scientific Instruments. XII. Music. XIII. Machinery, Transport, &c. XIV. Electricity. XV. Leather and India-rubber. XVI. Paper. XVII. Photography. XVIII. Sanitation. XIX. XX. Fisheries. XXI. Sports. XXII. Gardening XXIII. German Colonies. XXIV. Hotels and Restaurants.

KANSAS HARD WHEAT.—Reporting on the products of Kansas, Mr. Vice-Consul Burrough says of wheat:—The grain known throughout the bread-stuff world as Kansas wheat, and the flour made of it, has advanced greatly in price and commercial importance during recent years. This is due mainly to two causes. First, from it is produced a sharp, granular flour—this is rich in gluten; it absorbs a great deal of water; and makes a strong sweet bread. Both the British and Continental European demands for Kansas hard wheat-flour have more than doubled in the past two years on this account. For the same reason the American demand, especially at the south and east, has expanded remarkably. The other reason for the growing popularity of this grain is, that it is of a hardy nature. It stands more drought and freezing weather than any other wheat grown in the southwestern winter wheat region of the United States. It was originally introduced into Kansas by Russian emigrants, but has spread over the State until, at least, two-thirds of the wheat area of that commonwealth is annually seeded with this grade of wheat.

Journal of the Society of Arts.

No. 2,229. Vol. XLIII.

FRIDAY, AUGUST 9, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

RECENT AMERICAN METHODS AND APPLIANCES EMPLOYED IN THE METALLURGY OF COPPER, LEAD, GOLD, AND SILVER.

By James Douglas.

Lecture I.—Delivered April 22, 1895.

Mechanical Appliances and Mechanical Methods.

It is difficult to distinguish between essential improvements in an art and ingenious contrivances designed to meet the exigencies of local conditions. Certain American inventions and adaptations have become to metallurgists, the world over, the tools without which they cannot work. Such belong, without contradiction, to the former category, while others must be relegated to the latter; but, inasmuch as the peculiar conditions which give rise to, and favour the use of, certain of these local devices exist in other exceptionally situated quarters of the globe, such improvements are to metallurgists thus circumstanced as valuable as invention of more general utility.

To the former class belongs, for instance, the Blake crusher, the parent of a large progeny of comminuting machines, designed with the essential elements of a fixed and a moveable jaw. It is an American invention, which is an inseparable adjunct to every metallurgical establishment everywhere. To the latter class belongs the water-jacketted furnace. It is not accepted in Europe, or even by all establishments in the Eastern States of America as a substitute for the brick furnace. Yet without it smelting could not be economically conducted in certain remote regions of Western America, or in the mining districts of other continents where refractory building material is scarce and costly.

What is true of mechanical appliances is equally so of certain metallurgical processes admittedly American, some of which—while valuable, because peculiarly adapted to local, or even special climatic conditions—are not so accurate and economical as to receive the stamp of general acceptance.

There are, in fact, two standards by which metallurgical, as well as other technical processes and practices, are to be judged—the standard of absolute excellence, and that of economical utility. The series of operations by which the minutest trace of each valuable constituent of an ore is recovered, represent, no doubt, the highest standard of the art of metallurgy; but, on the other hand, the process by which most money can be made out of a given ore in a given locality is generally awarded, in practice, the reward of adoption, even though it be wasteful and reprehensible from a scientific and technical point of view. Remembering that most of the larger mineral deposits of the United States are situated far from the centres of population and of chemical industry, where, therefore, bye-products are of little or no value, where fuel and re-agents are dear, and where labour, owing to its scarcity and the great cost of living, commands higher wages than in any other section of the Union, it can readily be conceived that the simplest, not the most complicated, even though it be the most perfect; the speediest, not the most thorough process, will be selected, with the view to saving only the most important constituents of an ore, regardless of its subsidiary and less valuable elements. Men who risk their money, and those who forfeit their comfort to recover what Nature has hidden in the wilderness, are liable to overlook small savings in their hunt for wealth, and to be guilty of committing the crime of permitting heavy metallurgical waste, so long as it does not involve pecuniary loss.

These conditions impressed its character originally on American metallurgy; and where similar conditions are repeated in other recently discovered mining fields, the same features are likely to be reproduced in their practice. And to the present day, American metallurgy retains some of the traits of its early youth, especially a tendency to work on a grand scale, and to subordinate scientific accuracy to large output. Nevertheless, there is exhibited in all the new establishments, not only great ingenuity in arranging the machinery so as to attain the maximum of automaticity, but a freedom from prejudice, which

permits of a candid examination, and due estimation of novel inventions, coupled with a keen appreciation of the value of scientific training in the technical staff. The result is that work is done not only cheaply but well, and that even though American metallurgical establishments be not types of those completely equipped factories, where every constituent of the ore is saved, and the value of the bye-products rises higher than that of the metal which is the primary object of search, they afford instructive examples of the judicious application of mechanics to metallurgy, and of the extent to which capacity serves as an auxiliary to economy.

In fact, the replacement of hand-labour by machinery is the most conspicuous difference between the establishments of America and those, with few exceptions, of the Old World. This peculiarity of American practice has been forced upon the profession by the high cost of labour as compared with the European standard, in all the mining districts of the United States, and especially in those of the Rocky Mountain regions.

For instance, in Butte Montana, miners and carmen get $3·50, equal to 15s. per day; timber men $4·00, equal to 16s.; furnace feeders and tappers $4·00, equal to 16s.

In Arizona, engineers get $4·00, equal to 16s. per day; mine timber men $3·50, equal to 14s.; miners $3·00, equal to 12s.; furnace feeders and tappers $3·00, equal to 12s.

On the Comstock, $4·00, equal to 16s., is still paid to miners.

In Colorado, despite the decline in the price of silver, miners' wages are nowhere lower that $2·50, equal to 10s., and, in places, are maintained at $3·00, equal to 12s.

In California, owing to the lower cost of living and the denser population, wages are lower than elsewhere in the West, though miners generally get $2·50, equal to 10s.; timber men $3·50, equal to 14s.; and carmen $2·25, equal to 9s. Good mill men generally receive $100 per month, equal to £20.

On the south shore of Lake Superior, miners get about $2·00, equal to 8s. a day, and mill men about $1·75, equal to 6s. 6d.

Such being the rate of wages in the principal centres of metal mining and metallurgy, it follows that from the initiation of the industry, economy of labour was the *sine quâ non* to financial success. With a steady decline of late years in the price of products, with which a corresponding decline in the price of labour has not everywhere taken place, the necessity of replacing manual by mechanical energy has grown more and more imperative. Therefore, not only in the ore concentration and in the gold-mills, but in the furnace plant, the aim of the designer is to use to the utmost the force of gravity, the power of water, and the energy of steam and electricity in moving the material to be operated upon, and to confine man's intervention, as much as possible, to the function of superintendence.

In reviewing the field of the mechanical and metallurgical treatment of the ores of copper, lead, gold, and silver, my aim will not be to describe in detail the working of any process, but to direct your attention only to machinery and methods which may claim to be specifically of American origin, and cursorily to the latest practice in the American treatment of these metals.

Crushing Machines.

To American inventors several distinct types of crushing machinery owe their creation, notably the various rock breakers and the steam stamp. Through their instrumentality, surprisingly large quantities of ore can be crushed to sizes suitable for concentration by machinery occupying so small a space as to render it possible to turn out from a single mill the enormous yield which it is the ambition of our large mine owners to produce.

The ordinary Blake crusher is almost as familiar a piece of machinery as the nut cracker, which is said to have suggested to its inventor, Whitney Blake, in 1858, the idea of breaking stones between a fixed and a movable jaw. The latter, in the orginal design, rested on a step, and received at its upper extremity motion through a toggle joint. In the latest form, as built for Blake by the Robinson-Rae Company of Pittsburg, the frame is of structural iron or steel, the movable jaw hangs from two trunnions, and maximum motion is communicated to the free lower end of the jaw, by which means a freer discharge is obtained and less slime made than by the older form. But to insure a more uniform size of particles, the Dodge and the improved Krom crushers retain the original mode of communicating motion to the upper extremity of the movable jaw. Many other minor variations in design have been introduced by manufacturers in order to give some peculiar motion to the jaw, or to relieve the frame and working parts of dangerous strain; but the main features of the Whitney Blake original crusher have been retained in all. Theodore

A. Blake has proposed for, and applied to, the granulation of ore, a series of breakers, placed one above the other, with jaws set closer and closer, the breakers for the final crushing being provided with multiple jaws worked by one pitman. One of the concentrating mills of the Chateaugay Iron - Ore Company, of New York, is built with crushing machinery of this description. It does good work on dry ore, but only on dry ore. The system might be advantageously applied in arid regions to brittle ores, as the data of cost, from actual working, furnished at Chateaugay were favourable, but as the company has not followed the same system in its enlarged plant, it is presumable that in that climate it is found to be attended with drawbacks.

In another type of breaker the movable jaw is a vertical cone, which oscillates with a slightly gyrating motion in a heavy cup-shaped mortar open at top and bottom. The movable jaw being circular, crushes all round its periphery, whereby the crushing surface is increased, the effective opening is enlarged, and the strain upon the jaw is equalised. There are on the market a number of different varieties of this excellent type of crusher, the most prominent being the Comet, built by Fraser and Chalmers, the Gates, built by the firm of the same name, the Lowry, and McCully. Where large capacity is demanded and vertical space can be spared, especially if the rock to be crushed be tough, these breakers are most efficient. The first patent for this decided modification of the Blake seems to have been taken out by Gates and Fraser, then in partnership, in 1865 (U.S. patent 5,573, October 24th, 1865). In it a roller-shaped jaw oscillates in an open horizontal trough perforated by a slot in the bottom.

Rolls, as crushers for the granulation of ores, retain their position in all the smaller works of America, and in some of the larger, though they have been generally displaced by the steam stamp where very large quantities are to be operated on. In their construction there is less room for radical change than in other classes of machinery. On both sides the Atlantic the weighted lever has, in advanced works, given place to steel or rubber springs, steel has supplanted cast-iron for the shells, and band-wheels have been substituted very often for gearing. These improvements—as Krom, who makes certainly one of the best rolls, has pointed out—permits of the high speed, one hundred revolutions and over, which is the tendency of American practice.

The old-fashioned stamp with its clumsy wooden stem, square shoe, and up and down motion, is an antiquity in America. It has been replaced in all the gold and silver mills, where some other pulveriser is not employed, by the revolving stamp battery of Californian or Colorado pattern, and in most of the large concentrating mills by the steam stamp. Both improved stamps are reported to have been first tried on Lake Superior.

The first battery, with the stem revolved by cam and tappet, is said to have been erected in the sixties, by Gates and Fraser, for the Quincy Company, but the revolving stem did not prove to be applicable to the crushing of Lake ore. The last large mill in America using the up and down drop stamp was the Central of Michigan, which closed down last year.

The Nasmyth hammer suggested to Jordan (Philip's and Darlington's "Records of Mining and Metallurgy," 1857, page 125) the advantage of the direct impact of a stamp operated by steam; but the first practical application of the principle seems to have been made by W. Ball, of Chicopee, Mass. Ball is said to have erected his first mill at the Copper Falls Mine, on Lake Superior, in 1855, and there to have driven his stamp by steam, employing the rudiments of the gearing still in use, but discharging by only one gate from the mortar. At the Pewabic Mill, built in 1860, Ball added an additional gate. As now constructed, the mortar discharges through four gates, and the machine has been so improved in every detail, that one stamp head, moved by a 20-inch cylinder with a 30-inch stroke, crushes of hard rock 250 tons a-day, coarse for concentration, or 150 tons fine for amalgamation. Each stamp is an isolated machine. The head is attached directly to the rod of a piston moving in a vertical steam cylinder, which is supported on four heavy converging pillars. These rest on a solid frame, and hold in place the mortar. This, till recently, was built on an elastic bed, but it is now made to rest on a solid bed-plate, whereby the yield has been notably increased. The steam valves are operated by eccentrics and rods, which derive their motion from some external source of power, generally, the main shaft of the mill, through one or more countershafts. The weight of the superstructure of a single stamp is about 140,000 lbs. While it will do a stupendous amount of work, it consumes eight or nine tons of coal daily, absorbs 150 horse-power, and requires, in order to

evolve its full efficiency, that it be supplied with not less than 7,000 gallons of water per ton of ore crushed. The original Ball stamp has been modified by the inventor himself, by Leavitt, the eminent engineer of the Calmet and Hecla Co., and by others.

The atmospheric stamp of the type made by Husband in this country has been very little used.

Many mills, claiming to pulverise more economically in first cost or in operating expense than the stamp, are soliciting public patronage, but none have met with much encouragement, except the Sturtevant, for dry crushing, and the Huntingdon for wet. The Sturtevant mill grinds by the attrition of particle against particle in two hollow cylinders revolving rapidly in opposite directions within a housing, lined with a screen of the desired fineness. It is used more successfully for granulating ore than for very fine grindings, as once the particles have been reduced to a certain fineness, the force of their impact is insufficient to effect their own further subdivision. The Huntingdon is a centrifugal roller mill. Four rollers, keyed to as many vertical spindles, revolve horizontally against a ring die, the pulp being discharged as rapidly as it attains the desired fineness through screens, secured in five ports, which open on the walls of the cylinder. When used for gold ores, amalgamation is effected in the mill and on an apron, as in the stamp mill. It is essential to success that the ore be reduced to coarse particles, say by rolls, before entering the mill. In the Belmont mill, Telluride, Colorado, four 6-foot Huntingdon mills, fed from four separate sets of coarse rolls, crush 80 tons of rock daily. The mill, when I saw it, was driven by a 50 horse-power motor, deriving a 3,000 volt current from a power plant 14 miles distant, but the motor was being forced above its capacity. Two more mills have since been added, and 100 horse-power motor has replaced the smaller one. The Huntingdon is admirably suited for regrinding the coarse tailings and middlings of a concentrating mill.

On Concentration.

In the department of the mechanical concentration of ore there has not been the same originality of invention as in that of the comminution of ore; but American millmen have shown the national impartiality and freedom from prejudice in their choice of foreign methods and their combination of foreign appliances. The smaller concentrating work are usually designed after German models with breaker, rolls, revolving trommels fo sizing, and multiple compartment of Hartz jigs the slimes being treated, after hydraulic sizing on Evans tables, which are modified roun German buddles, or on revolving belt-vanners Wherever steam stamps are used, trommel and all other mechanical classifiers have bee abandoned in favour of hydraulic classifiers several novel forms of which have been devised

The Evans classifier consists of a dee trough, traversed by partitions, which dete mine the height to which the sand shall b allowed to collect in the trough. In the floo of the trough are pockets provided with a dis charge, and into which a regulated flow water is admitted by a vertical pipe on whic a movable disc can be lowered or raise whereby a funnel-shaped cavity of the desire size for each class of grains can be excavate in the bed of sand which collects in the pa tition. The sloping bed of sand also acts a concentrating surface. Another classifier that patented by Mr. Coggin, of the Calum and Hecla. In it the classified ore particl enter the iron pipe itself, which crosses th pockets, through the same perforation whic supply the ascending current. They are di charged through a regulated aperture in th free end of the pipe.

On Lake Superior the Collom jig with tw following screens is almost exclusively use In it the pistons, in adjacent compartment receive a sharp shock from a rocker, and a returned to position more slowly by the reco of a spring. But the Hartz jig with its eccen tric motion and multiple compartments is mo popular in the West. Professor Richard opinion is that "the Collom jig works be with much water with a hydraulic separat and upon a two-mineral separation, while th Hartz jig works with less water with two, thre or four mineral separation, with close sizin or with hydraulic separation and with a dee sieve for very coarse sizes. But, on the oth hand, with all these advantages, its adjus ments are not nearly so handily made. Th Hartz is, therefore, a much more universal ji than the Collom while the Collom is muc handier than the Hartz."

The exigencies of dear labour, if no oth reasons, have expelled all the English opera tions of slime concentration from America practice. Where large quantities have to b handled, the Evans revolving table is pr ferred, built often as a double-decker. F

concentrating the sulphurets of gold and silver mills there is almost universally used some form of revolving belt. The original vanner as designed by Capt. Frue, was suggested by the old Brunton belt. The usual procedure in a gold mill is to discharge the water and unclassified pulp from the amalgamation apron of five stamps upon two vanners, which automatically collect the sulphuretts and discharge the tailings. The working is certainly simple, but the results imperfect. A simple device for reducing the loss of slime is worth recording. Mr. McCoy, at Ouray, Colorado, throws slanting jets of air against the stream of water and pulp, just below the point of feed. The current of air throws back some of the very fine slime which would otherwise float away and be lost.

Turning to the works themselves we find the largest concentrating establishments to be on Lake Superior and in Montana, but there are peculiarities about the mill at St. Joe, in Missouri, worth noticing.

Lake Superior Copper Concentrating Mills.

Lake Superior copper ores consist either of particles of native copper disseminated through a soft trap, as in the Quincy and Atlantic, and other amygdaloidal mines; or of metallic copper, cementing together exceedingly hard pebbles as in the Calumet and Hecla, Osceola, and other conglomerate mines. The percentage of copper is never high, varying, in copper recovered from 0·7 per cent. in the Atlantic to say 3·5 in the Calumet and Hecla. But the copper contents in every Lake, as in other mineral deposits is variable, at one time higher at another lower in the same mine. This variation of course influences the yearly cost of extraction. What, however, chiefly determines the much lower cost of mining and concentrating the ore of the amygdaloidal mines than of the conglomerate is the greater thickness and softness of the amygdaloidal ore bodies.

In the mills, of which the new Atlantic mill is a good specimen, the ore previously broken to size for stamping in the rock-house at the mines, is crushed in steam stamps at the rate of from 200 to 300 tons per day, according to the hardness of the rock. The stamp work is passed through the classifiers above described to 28 jigs per stamp in the Atlantic mill, and 34 in the Calumet and Hecla mill, and the slimes to four round buddles. The work is done by the flow of water. The coarse ore from the separators passes to two compartment Collom jigs. The tails from screen 1 are re-treated on screen 2, and passed thence into the tail race. The hutch work, on the contrary, is carried by the flow of water to a series of similarly constructed jigs on a lower level, where each size is cleaned on corresponding screen.

(F. F. Sharpless in Proceedings of Lake Superior Mining, instituted 1894.)

It will be seen that the work is done by the flow of water and the machinery is necessarily arranged on descending steps. The quantities of water which must be raised for that purpose by the Calumet and Hecla pumps on Torch Lake to feed their 22 stamps, all of which, however, are never dropping at the same time, would be 110,000,000 gallons daily. Their pumps have that capacity, but the 60,000,000 gallon pump—the Michigan—is usually sufficient to do the work required.

Under Mr. Stanton's skilful, technical, and commercial management, the work of the Atlantic mine and mill may be taken as exhibiting the minimum of cost of any of the Lake Superior establishments. The following summary of results from the report of 1894 speaks for itself:—

Rock stamped	315,626 tons	
Product of mineral	5,687,665 pounds	
Product of refined copper ..	4,437,609 pounds	
Yield of rock (per ton)	14 pounds – ·703%	
Total cost of mining, selecting, and so on	$0·7518	
Transporting to mill	$0·0303	
Stamping and separating ..	$0·2330	
Total cost of mining and concentrating	———	$1·0151
Freight, smelting, and marketing	$0·1771	
Total cost of mining, treating, and marketing the product of a ton of rock. .	$1·1923	
Gross value of product	$1·3376	
Profit per ton of rock	$0·14 cents.	

It must be borne in mind, however, that the Atlantic ore, as already pointed out, can be mined and milled more cheaply than any conglomerate ore. To take, as an instance, one item alone of expense, the life of a stamp shoe on conglomerate rock is only from 4 to 5 days, whereas, it will last 14 to 15 days on amygdaloidal trap, and crush 3,000 tons of rock. The very low per-centage of copper in Atlantic rock can, of course, be recovered profitably only by dint of good management and good machinery, and at best the margin of profit

is small. The Quincy Company, working amygdaloidal rock, which has run above 3 per cent. and never below 1 per cent., is experiencing, in the low cost of its copper, the full advantage of the new machinery and better methods, which have been adopted in the new and enlarged mill recently erected.

Montana Concentrating Mills.

The concentrating works of the Anaconda Company were originally planned on the German system, with rolls and sizing screens, but repeated stoppages for repairs induced the management to adopt the steam-stamp and hydraulic classification. The coarse tailings and middlings, which were formerly crushed by Heberle mills, now pass to a steam stamp on the level of the fine jigs. The arrangement of the mill differs from a Lake mill, in that all the ore which will pass through a grizzly with 1-inch openings placed between the breaker and the stamp, which amounts to about one-third of the total, is concentrated on roughing jigs, the tailings from which are re-crushed. This gives each stamp-head an initial capacity of about 350 tons.

At the Great Falls of the Missouri, the Boston and Montana Company have their large concentrating works moved by water-power. Their mill is in three sections, two provided with rolls and revolving screens, one with a steam stamp and hydraulic separators. The preference seems to be for the rolls on account of their smaller production of slimes. The system adopted is one of progressive crushing and concentration. The product of the first sizing screen, with 1¼ holds, passes the jigs, the tails of which are re-crushed.

Concentration of Galena at St. Joe, Missouri.

There are large and very interesting works at Bonne Terre, Missouri, which treat the product of the St. Joe lead mines. The system of jigging is a reversion to the English type, which is gaining adherence even in Germany. The scarcity of water at the St. Joe mill has, to a certain extent, determined the method adopted. Eight hundred tons dry ore daily are crushed and screened through trommels, with six m.m. holes, then wetted and concentrated unsized, in 92 two-compartment jigs. The jig pistons move horizontally in a horizontal cylinder between the two compartments. Three sieve jigs are used for coarse slimes. Professor Munroe, of Columbia College, attributes the success in thus jigging coarse and fine including slimes, to the coarseness of the bed. He says:—

"The plan of jigging sands and slimes together makes it possible to treat very much finer material with success than has heretofore been supposed possible. The limit for successful work on jigs is generally placed at about 1 m.m. The successful jigging of stuff ⅛ m.m. and less marks a decided advance in the art of dressing. The coarse grains form the interstitial channels in which this very fine stuff can be concentrated. It is well known that any attempt to treat stuff finer than 1 m.m. by itself, results in very imperfect working of the jigs, the losses being large, and the capacity of the jigs small. The advantage of this system of jigging is the large proportion of sands successfully treated and finally disposed of by the roughing jigs alone. Out of 800 tons per day, only 136 require further treatment, viz., 30 tons raggings, crushed and treated on the three-sieve jigs, 66 tons fine sand, also treated on the three-sieve jigs, and 40 tons of slimes treated on the side bump tables."

The treatment of the hutch work and crushed raggings in a trunking machine, spitzkasten, and finishing jigs, and of the slimes on percussion tables, completes the concentration. The results speak favourably for the saving of material by this modified English hutch system as compared with the Lake method. The loss of lead at Bonne Terre is 27·4 per cent., as against from 28·5 per cent. to 31 per cent. of copper in the Lake mills. The comparative cost of dressing at this mill, and at the Atlantic mill is, however, widely in favour of the Atlantic, if not of the Lake system. The figures given for Bonne Terre are:—

	Per ton.
Labour	13·4 cents.
Repairs	10·0 ,,
Supplies	3·5 ,,
Coal	9·5 ,,
	36·4 ,,

As against 23·30 cents. per ton at the Atlantic mill.

As bearing on the relative cost of crushing by rolls or steam stamps, the following figures by Munroe are interesting. At St. Joe, the rolls crush and the mill concentrates 33·5 tons of a limestone ore per ton of coal. At the Atlantic mill stamps crush 38·34 tons of amygdaloidal trap. At St. Joe the elevating is done by centrifugal pumps with marked economy over the cost of running and maintaining bucket elevators.

›LD HYDRAULICING AND THE MILLING OF FREE GOLD ORES.

Within the scope of the mechanical treat- ›nt of ore falls legitimately the operation of ld hydraulicing, and the milling of free gold d silver ores. In both these branches the n of the American metallurgists has been handle the largest possible amount of iterial with the smallest possible expendi- re of man power through the agency of ıchinery, or the impact and carrying power water.

The pioneers of California may, without vil, claim credit for introducing the hydraulic ethod of extracting gold from auriferous avels. As early as 1854, Professor Blake w it applied in Michigan city, California, ıere even prior to that date acres of drift had en removed by water jets conveyed through nvas hose, and forced through a stove pipe. ıe results since attained by improved appli- ıces and higher pressure, whereby gravel elding 3 cents per yard have been pro- ably worked are too well known to need peating.

The addition of the hydraulic elevator has tended the sphere of hydraulic mining to calities where the gravels have to be raised the level of the sluices. Perry, in Australia, ›ed a water jet under pressure to raise and sintegrate gravels, but Hendy's modification the Cranston machine is the jet elevator enerally—if not exclusively—used in the nited States. The gravels broken down by e ordinary nozzle may be carried by the flow water through a grating into the hopper of ıe elevator. The quantity of water and gravel jet elevator will handle of course depends ı the volume and pressure of the water. endy tells me one of his elevators at the orth Bloomfield Company's mine is lifting 400 cubic yards per day of water and gravel › a height of 90 feet by water under 225 feet ressure.

A still more important innovation is the ıtroduction of the steam shovel, coupled to n amalgamator, for handling auriferous ravels, where water is scarce or the ground o level for hydraulicing. Only partial uccess has as yet attended this application f the steam shovel, where heavy boulders are mbedded in the gravels. The practice is › scoop up the gravels, coarse and fine, levate by the buckets of the steam shovel, nd discharge into a screen. What does ot pass its meshes is removed by a carrier, clear of the trench which the machine is excavating. The gravel which passes through the trommel is agitated by jets of water as it travels through a trough-shaped amalgamator, whence it is pumped to the waste dump by a centrifugal pump. The Bucyrus Steam Company have been the pioneers in this direction. The difficulties encountered have not been insuperable, while the advantages to be obtained are incalculable. The company claims that gravels can be worked, even where fuel is as costly as in most parts of the West, for 10 cents per yard, at the rate of 60 cubic yards per hour.

The gold mill, with its series of automatic operations, is another offspring of Californian ingenuity. In it manual labour is almost entirely replaced by ocular labour, for superintendence, and not work, is the function of the mill hands. The ore, dumped into the breakers, falls into large pockets, whence it slides into automatic feeders, which supply the stamps with regulated quantities. The free gold is extracted partially by liquid mercury in the mortars and by copper plates attached to their sides, and partly on an apron of amalgamated copper plates, over which the crushed pulp flows as it issues from the battery screen. Frue, or other automatic vanners, receive the tailings, separate the sulphurets, and discharge the waste. When the power is supplied by water, and the stream is divided to Pelton wheels, coupled directly to the separate groups or even pieces of machinery, the absence of intermediate running gear increases not only the sense but the reality of automaticity, and makes a skilfully arranged and thoroughly equipped Californian gold mill one of the triumphs of modern mechanical metallurgy. The saving in most gold mills may not be close, but they undoubtedly supply the only means of economically treating low grade ore. The distribution of water power is well illustrated at the North Star mine and mill in Nevada county, California.

At the hoisting works, under a 237 foot-head, an 8-foot Pelton wheel moves the Cornish pump, and a 6-foot Dodd wheel is coupled to the hoist. At the mill, under 277 foot-head, a 6-foot Pelton wheel runs 40 stamps with 90 miners' inches of water; a 3-foot ditto runs 16 vanners with 8 miners' inches; a 4-foot ditto runs 1 rock breaker with 20 miners' inches; a 3-foot ditto runs a dynamo with the water which has been used at the mine, under a low head of 40 feet. The Dodd wheel is fitted with triple nozzle distributors which permit of

the shutting off of water as the car ascends the incline.

The water which moves the North Star works is drawn from the South Yuba Water Company's ditch, and has already on its way to the North Star done service at the Empire mine and mill. After leaving the North Star it exerts its energy for the third time at the establishment of the Omaha Company.

Though no capital changes have been made in the gold mill of California of late, minor improvements will never cease to be devised, more especially now that it has become the equipment of the gold mines of three continents, and minute economies will be applied, which will continue to bring within the sphere of profitable working lean deposits previously neglected. Their product will more than compensate for the exhaustion of the richer mines. A large per-centage of California's gold production to-day comes from mines abandoned 20 or 30 years ago.

Where conditions permit of the economical treatment of a low grade ore the cost of milling is largely influenced by the quantity milled. For instance, of the two Homestake mines, Dakota, one with 80 stamps, treats 102,820 tons annually at a cost of 81 cents, whereas another with 160 stamps, treating 191,700 tons annually, does its work at a cost of 69 cents.

(Full details are given by Hofman, in his paper on "Gold Mills in the Black Hills," in "Transactions of the American Institute of Mining Engineers," 1889)

At the North Star mill, above referred to, between the years 1887 and 1893, 113,958 tons were milled, at a total cost of $92,981·55, or 8·16 cents per ton, distributed as follows :—

Labour (two men only per shift)	·328
Power, paid for water	·320
Quicksilver	·032
Other supplies	·816
	·816

The lowest record is probably that of the Dalmatia mine, El Dorado county, California, whose mining and milling, according to the last United States census report, cost, in 1889, 50 cents per ton, and that of the Spanish mine, Nevada county, California, whose mining cost 33 cents, and milling 24 cents, or a total of 57 cents, and which, therefore, realised profits out of a 65 cents ore.

Milling of Free Silver Ores.

The milling of free silver ores may also be included under the head of mechanical metallurgy, and it, as practised, likewis fulfils the imperative demand of America metallurgy for speed and capacity. A wester silver mill has no prototype in the old European practice. It was a Nevada ou growth of the California gold mill, employin the same crushing machinery, similarly con bined, but substituting amalgamating pa for battery and apron amalgamation (on a count of the greater resistance to amalgama tion of silver than gold) and settling pans, i which the mercury is collected from the pul As usually designed and worked, the o passes from the battery into settling tank whence it is shovelled, in charges of suitab size, to the pans. In them it is subjected fo hours to mercury, under the grinding actio of iron mullers revolving in close proximity t iron dies secured to the bottom of the pan. Live steam is usually injected. Chemica (salt and sulphate of copper) are generall added by rule of thumb, or no rule at al They undoubtedly play the same part as i the *patio* the Kröhnke, and the Freiber barrel processes, yielding subchloride c copper, which aids in the decomposition c the silver sulphides ; but it is difficult to dis tribute fairly the effects on the almalgamatio among friction produced by the grinding c iron on iron, heat, and the reactions due t the chemicals.

The Boss system is the most notable de parture from the original Washoe method. I it the pulp flows continuously through a serie of pans and settlers, the reaction being, it i claimed, accelerated by the thinner layer under treatment in each pan. But in th latest mill erected by Boss at Pachuca, Mexic he protracts the action beyond that exerted i the ordinary pan by reverting to barrel amal gamation.

Mr. E. E. Olcott gives me the following infor mation upon this new departure. He says :—

The stamps weigh 1,050 lbs., the mortars are lo with base, 4 ft. 6 in. by 4 ft., and are set upon we rammed concrete. The rapid grinders, like a bu stone mill, have the lower disc revolve at 200 revolu tions, and the pressure of the upper disc is adjuste by a hand wheel. From the special grinders the pul passes through a steam jacketed pipe to a lar wooden barrel. The salt and bluestone go into th barrel along with the pulp by means of a turn-tabl feeder. The barrel is fifteen feet long by six fee diameter inside dimensions, and in operation holds si or seven tons of ore. This barrel has proved a ver decided success. The mill has been run without i and with it until there is ample data showing from

to 6 per cent. better results by using the barrel. The pulp is two or three hours in passing through it and therefore the chemical treatment is that long before reaching the pans with no iron in contact except such as wears from shoes and dies in crushing. The pans are of iron inside as usual but are connected at bottom as well as at the top, and the quicksilver is run constantly into the first pan and flows through and is drawn out at the last settler continuously. The percentage saved is from 88 per cent. to 92·19 per cent., although the Pachuca ore requires careful treatment to get satisfactory results."

But free silver milling, owing to the comparative rarity of oxidised silver ores, unassociated with valuable quantities of lead or copper, owing to the heavy losses under the Washoe process, and to the greater saving made by smelting or leaching, is still practised on a large scale only in Nevada. Speaking generally the silver ores of Colorado are all smelted. Those of Butte are either smelted or chlorinated before milling, and the large mills of Tombstone are all idle. Wherever free milling is or was practised the tailings are rich. Those of the four large mills of Tombstone, Arizona, which turned out $16,000,000 of silver and gold between 1879 and 1884, were collected and have since been concentrated and smelted, for the recovery of the lead in the concentrates. The tailings of the Comstock have been the source of much bitter controversy and litigation. It was on the Comstock that Almarin B. Paul built the first silver mill on the Washoe system in 1859. The milling and mining have ever since been carried on there as separate industries. By established custom the tailings are claimed by the mills, which return to the miner only the bullion recovered from the heavy sands collected in the settling tanks. Yet, so valuable are the fine slimes and the partially exhausted tailings, that their re-treatment has always been a separate branch of the metallurgy of the great lode. Under these circumstances, what proportion of the value of Comstock ore has been saved in the first milling, and what lost and refound in the slimes and tailings has never been exactly known by the public. There is thus, it is claimed by some, a motive for the recklessness with which has been, and still is, handled the ores of these extraordinary mines, which, since their discovery in 1859, have yielded the almost incredible sum of $350,000,000 of gold and silver. The mills are supposed to recover directly 65 per cent. of the gold and silver. Hague, at the date of his "Report" in 1867, estimated the total recovery at 78 per cent.

While all structural details of the Comstock mills which are essential to rapid and uninterrupted working, have been brought to the utmost attainable perfection, the study of the chemical reaction of the process has been sadly neglected. Metallurgical economy has been subordinated to the exigencies of speculative owners and stock manipulators, who have required an enormous output, even though it involved necessarily heavy operating losses. To-day, the only mill running is the Chollar-Potosi, and that intermittently—a sad contrast to the days of Comstock prosperity, when there were in 62 mills 1,280 stamps dropping, to supply pulp to 1,032 pans and tubs.

Kröhnke's beautiful dichloride of copper method has never been practised on the Comstock or elsewhere in North America. There are not many ores suitable for it, and the plant would necessarily be too large and costly to handle large quantities of lean ore. Amalgamation in Freiberg barrels and the *patio* were both tried on the Comstock, but abandoned. It was claimed that the results were inferior and too slowly attained. The latter objection was doubtless valid, and the former may be accepted with some reservation. The space that would have been needed for Freiberg barrels, and the time required to successfully amalgamate on the *patio* were so incompatible with Comstock ideas and impatience, that the cumbersome German method, and the slow but thorough Mexican process, were probably not submitted to a fair trial, nor condemned on their merits.

But it is interesting in this connection to compare the record of good *patio* practice with that of the Washoe process, and to do so may correct some misapprehension as to the primitiveness of Mexican metallurgy. The largest *patio* floors in Mexico were those of the Hacienda Nueva, when it was running full, before the shutting down of the Fresnillo Silver Mines on Cello Proaño, near Zacatecas. Accurate returns have been published of the cost of mining and milling during the last long run between 1853 and 1862. Within that period 452,264 tons were treated, yielding 1,096,281 marks, equal to $9,828,598, or 2·42 marks, equal to 17·75 ounces, or $21·72 per ton. As the cost of mining was ultimately $1·63 per cargo of 300 lbs. or $10·88 per ton, and of the metallurgical treatment $11·16 per ton, the working cost exceeded the revenue by 32 cents,

and operations were suspended. The new works, whose machinery was operated by steam, were built between 1831 and 1834 at a cost of $340,000. They accommodated 64 tortas or piles of 120,000 lbs. each, and, therefore, when full there were, under different stages of treatment, 3,840 tons on the floors. Yet so slow is the *patio* process, that the weekly capacity was only 900 tons. Herein lies the insuperable objection to the process where a large output is obligatory. The first cost of construction is greater, and the ground occupied, namely, 900 feet by 900 feet, or nearly 20 acres, incomparably more so than than those for a silver mill of the same tonnage. A fifty-stamp Washoe mill would put through as much. The time of treatment varied with the season of the year from 15 days to 40 days, as against almost as many minutes in a mill using the Boss continuous process. But when we compare cost and perfection of work, the preference is not so decidedly in favour of the American method. During the period under review the ores had become baser and baser, and the cost of re-agents in some respects higher than they had been. There were paid $10 per ton for salt, $50 for magistral, $1·20 per lb. for mercury, and $22 for wood. It thus came about that the cost of treatment which had been previously $9·75 per ton, rose to an average of $11·16 per ton. The actual average yield for the whole period was 85·2 per cent. of the assay value, the variations being between 89·5 per cent. and 76 per cent. At that period the Comstock mills were charging $12·50 for milling a much freer ore, and returning only 62·65 per cent. Such ore as that of the Proaño would refuse to give a workable proportion of its silver to a Washoe mill, unless previously chlorinated in a furnace, and that could be effected in most Western regions only at a cost far in excess of that at which the chlorination on the *patio* floor is slowly effected. That the *patio* process has not been used in the Western States, where small quantities of rich ore in inaccessible regions had to be treated, is probably due to the average range of temperature north of the boundary line being below that at which the *patio* process can be successfully operated at all seasons of the year. Mr. Stetefeldt gives the result of recent *patio* operations at the Hacienda Sauceda, near Zaccatecas. There the total cost of reduction is $12·8, but the percentage of loss varies from only 7 per cent. when treating a 99 ounce ore to 10 per cent. when treating a 32 ounce ore.

The above examples are a confirmation o the thesis that speed and perfection do not, i metallurgy, always go hand in hand. But is none the less true that only by the aid machinery and the handling of quantity wit celerity can the demand of modern trade b supplied, and lean ore be treated. This go has always been the aim of the America metallurgist, and the time is drawing nea when the speed, which has already bee attained, will be maintained without sacrificin the accuracy, which, unfortunately, he canno yet claim for all his work.

Miscellaneous.

SANITARY INSTITUTE.

The Twentieth London Course of Lectures an Demonstrations for Sanitary Officers will be delivere at the Parkes Museum on Tuesdays and Fridays at p.m., from September 3 to November 22, 1895, a follows:—

Sept. 3, "Elementary Bacteriology," R. T Hewlett, M.D., M.R.C.S. Sept. 6, 10, 13, 17, 20 24, "Elementary Physics and Chemistry," John Castell-Evans, F.I.C. Sept. 25, Inspection and Demonstration in the Parish of St. George's, Hanover-square, at 2 p.m. Sept. 26, "Ventilation Warming, and Lighting," Louis Parkes, M.D.

Oct. 1, "Sanitary Law; English, Scotch, and Irish; General Enactments, Public Health Act 1875; Model Bye-Laws, &c.," Herbert Manley M.A., M.B. Oct. 2, Inspection and Demonstration of Stoneyard and Disinfecting Station, Marylebone, at 3 p.m. Oct. 4, "The Law Relating to the Supervision of Food Supply," Prof. A. Winter Blyth, M.R.C.S. Oct. 5, Inspection and Demonstration of the Wimbledon Sewage Works, at 3 p.m. Oct. 8, "Sanitary Laws and Regulations Governing the Metropolis," Prof. A. Winter Blyth. Oct. 9th, Inspection and Demonstration at Casual Wards, Milman's-street, King's-road, and Disinfecting Station, Lot's-road, Chelsea, at 3 p.m. Oct. 11, "Objects and Methods of Inspection," J. F. J. Sykes, D.Sc., M.D. Oct. 12, Inspection and Demonstration of Southwark and Vauxhall Waterworks, Hampton, at 3 p.m. Oct. 15th, "Nature of Nuisances, including Nuisances the abatement of which is difficult," Arthur Newsholme, M.D. Oct. 16, Inspection and Demonstration of the Disinfecting Station, &c., at St. Pancras at 3 p.m. Oct. 18, "Trade Nuisances," Prof. A. Bostock Hill, M.D. Oct. 19, Inspection and Demonstration of Harrison and Barber's Knacker Yard, Whitechapel, at 3 p.m. Oct. 22, "Water Supply, Drinking Water, Pollution of Water," Prof. W. H. Corfield, M.A., M.D. Oct. 23, Inspection and Demonstration of the East London Soap Works, Bow, E., at 3 p.m. Oct. 25, "Diseases of

Animals in relation to Meat Supply" (characteristics of vegetables, fish, &c., unfit for food), Alfred Hill, M.D. Oct. 26, Inspection and Demonstration of Richmond Main Sewerage Works, Mortlake. Oct. 29, "Infectious Diseases and Methods of Disinfection," Edward C. Seaton, M.D. Oct. 30, Inspection and Demonstration of Disinfecting Apparatus and Model Steam Laundry, St. John's Wharf, Fulham.

Nov. 1, "Principles of Calculating Areas, Cubic Space, &c.; Interpretation of Plans and Sections to Scale," C. H. Cooper, A.M.Inst.C.E. Nov. 5, "Sanitary Appliances," George Reid, M.D. Nov. 6, Inspection and Demonstration in the Parish of St. George's, Hanover-square, at 2 p.m. Nov. 8, "Sanitary Building Construction," T. Roger Smith, F.R.I.B.A. Nov. 9, Visit and Inspection of the Sewage and Destructor Works, Ealing, at 2.15 p.m. Nov. 12, "Details of Plumbers' Work," J. Wright Clarke. Nov. 13, 20, Inspection of the L.C.C. Common Lodging House, Parker-street, Drury-lane, at 3 p.m. Nov. 15, "House Drainage," W. C. Tyndale. Nov. 19, "Sewerage and Sewage Disposal," Prof. Henry Robinson, M.Inst.C.E. Nov. 22, "Scavenging, Disposal of House Refuse," Charles Mason, Assoc. M.Inst.C.E., A.R.I.B.A.

Obituary.

Sir Thomas Wade, K.C.B., G.C.M.G.—Sir Thomas Francis Wade, the distinguished sinologist, died on Wednesday night, July 31st, at Cambridge. He was the eldest son of Colonel Thomas Wade, C.B., and was born in 1818. He was educated at Harrow, and entered the 81st Foot in 1838. In the following year he joined the 42nd Highlanders, and two years afterwards became lieutenant in the 98th Foot. He first saw service in China in 1842, and was appointed successively interpreter to the garrison of Hong-kong, interpreter in the Canton dialect to the Supreme Court of Hong-kong, and Assistant Chinese Secretary. In 1855 he was sent by the late Sir John Bowring on a special mission to Cochin China. His knowledge of the native tongue and his equally valuable familiarity with the character of the Chinese people were of good service to Lord Elgin's mission to China, to which he was attached from 1857 to 1859, in which year he was appointed Chinese Secretary to the English mission, and in that capacity accompanied Lord Elgin's special mission to Peking in 1860. In 1862 he received the appointment as Chinese Secretary and Translator to the British Legation, and from June, 1864, to November, 1865, he was acting Chargé d'Affaires in Peking. In July, 1871, he was appointed Envoy Extraordinary and Minister Plenipotentiary, and Chief Superintendent of British Trade in China. He retired on a pension in 1883. On April 21st, 1891, Sir Thomas Wade read a paper before the Foreign and Colonial Section on "Some Vicissitudes in the Story of China," for which he received the Society's silver medal. He also took a prominent part in the discussion of the Opium Questien in the Indian Section in March, 1892. He was the author of the "Tzü-Erh Chi," which dealt with the Chinese language both colloquial and literary. He received from Cambridge University the honorary degree of D.Lit. in 1886, and in 1888 was elected Professorial Fellow of King's College, Cambridge, on his appointment as first Professor of Chinese. He deposited his valuable Chinese library in the University Library during his lifetime. Sir Thomas Wade married, in 1868, Amelia, daughter of Sir John Herschel.

General Notes.

Leeds Photographic Exhibition.—A Photographic and Process Exhibition will be held in the City Art Gallery, Leeds, and opened on Monday, September 23rd, to remain open for two months. The Exhibition will be held under conditions in accordance with the resolutions passed at the Conference of Judges, held under the auspices of the Societies affiliated with the Royal Photographic Society. The schedule of classes is as follows:—Section I., General Photography (Class I.), photographs not having previously gained an award at any open exhibition; (Class II.) photographs which have gained an award at an open exhibition; (Class III.) lantern slides. Special silver and bronze medals are offered for competition by societies for the best series of photographs (not less than twenty in number) illustrative of Yorkshire scenery. Section II., Black and White and Monochrome Drawings suitable for reproduction by photo-mechanical processes (see separate prospectus to be had on application). Section III., Photo-mechanical Processes (Class I.), intaglio work (line and half-tone); (Class II.) half-tone work (surface printing), with screen; (Class III.) half-tone work (surface printing), without screen; (Class IV.) line work (surface printing); (Class V.) colour processes of all kinds.

The Japanese Match Industry.—In 1892 matches ranked fourth among the articles exported from the port of Kobé, but since then the exports have largely increased, and in 1893 the value amounted to 3,235,000 yen, or an increase of more than 1,500,000 yen over the figures for the preceding year. The *Bulletin du Musée Commercial* says that a large number of new match factories were established in Japan in the course of the year 1893, principally in the neighbourhood of Kobé and Osaka. These two towns tend more and more to become the centres of the industry, as may be seen from the fact that in 1893 the value of the exports was 3,417,000 yen out

of a total value of 3,558,000 yen for the whole of Japan. The production at Osaka is about half that at Kobé; at the latter place the output is principally for the export trade, while at Tokio and elsewhere it is for local consumption. The principal destinations of matches from Japan are Hong-Kong, China, and India, which imported in 1893 to the value of 2,500,000, 636,000, and 294,600 yen respectively. India and Corea are commeneing to develop a trade in Japanese matches which also seem to be entering into competition with the European article on the Australian markets.

THE LIBRARY.

The following books have been added to the Library since the last announcement:—

Bennett, A. R.—The Telephone Systems of the Continent of Europe. (London: Longmans, Green and Co., 1895.) Presented by the Publishers.

Bernstein, A., Ph.D.—A Text-book of Organic Chemistry: second English edition, translated by George M'Gowan, Ph.D. (London: Blackie and Son, 1894.) Presented by the Publishers.

Blackburn, Henry—Art of Illustration. (London: W. H. Allen and Co., 1894) Presented by the Author.

Carnegie, Douglas, M.A.—Law and Theory in Chemistry: a companion book for students. (London: Longmans, Green and Co., 1894.) Presented by the Publishers.

Clapperton, George. — Practical Papermaking. (London: Crosby Lockwood and Son, 1894.) Presented by the Publishers.

Crookes, William, F.R.S.—Select Methods in Chemical Analysis—chiefly Inorganic. (London: Longmans, Green and Co., 1894.) Presented by the Publishers.

Cummings, Linnæus, M.A.—Heat treated Experimentally. (London: Longmans, Green and Co., 1894.) Presented by the Publishers.

Derby, Edward Henry XVth Earl of.—Speeches and Addresses selected and edited by Sir T. H. Sanderson and E. S. Roscoe, with a prefatory memoir by W. E. H. Lecky. 2 vols. (London: Longmans, Green and Co., 1894.) Presented by Sir T. H. Sanderson.

Ealing, Electric Lighting of.—Description of the Undertaking. (Reprinted from the *Electrical Engineer.*) Presented by Messrs. Bramwell and Harris.

Everett, J. D., D.C.L., F.R S.—Elementary Treatise on Natural Philosophy based on the Traité de Physique of A. Privat Deschanel. (London: Blackie and Son, 1894.) Presented by the Publishers.

Holtzapffel, Charles.—Turning and Mechanical Manipulation. Vol. 3. Revised and eularged by John Holtzapffel. (London: Holtzapffel and Co., 1894). Presented by J. J. Holtzapffel.

Hedges, Killingworth.—Continental Electric Light Central Stations. (London: E. and F. N. Spon, 1892). Presented by the Author.

Institution of Civil Engineers.—Catalogue of the Library. (London: 1895.) Presented by the Institution.

Jago, William.—A Text-book of the Science and Art of Bread-making. (Simpkin, Marshall, and Co., 1895.) Presented by the Author.

Kingzett, C. T.—Nature's Hygiene: a Systematic Manual of Natural Hygiene. Fourth edition. (London: Baillière, Tindall, and Cox, 1894.) Presented by the Author,

Kitson, Arthur.—A Scientific Solution of the Money Question. (Boston U.S.: Arena Publishing Co., 1895.) Presented by the Publishers.

Lukin, James, B.A.—Turning Lathes: a Guide to Turning, Screw-cutting, Metal Spinning, Ornamental Turning, &c. (Colchester: Britannia Co., 1894.) Presented by the Publishers.

Martin, John.—Chats on Invention: being an attempt to train the faculties of Invention. (London: Offices of *Invention*, 1894.) Presented by the Author.

Muybridge, Eadweard.—Descriptive Zoopraxography. (Pennsylvania University, 1893.) Presented by the Author.

Newth, G. S.—A Text-book of Inorganic Chemistry. (London: Longmans, Green and Co., 1894.) Presented by the Publishers.

Notter, J. Lane, M.A., M.D., and R. H. Firth, F.R.C.S.—Hygiene. (Longmans, Green, and Co., 1894.) Presented by the Publishers.

Redwood, Iltyd I. — Theoretical and Practical Ammonia Refrigeration. (London: E. and F. N. Spon, 1895.) Presented by the Publishers.

Slingo, W., and A. Brooker.—Problems and Solutions in Elementary Magnetism and Electricity. (London: Longmans, Green and Co., 1895.) Presented by the Publishers.

South Kensington Museum.—Supplement to the Catalogue of the Science Library, 1891-5. (London: 1895.) Presented by the Department of Science and Art.

Statham, H. H. — Architecture for General Readers. (London: Chapman and Hall, Ltd., 1895.) Presented by the Author.

Stone, J. Harris, M.A., and J. S. Pease, B.A.—A Practical Ready Reference Guide to Parish Councils and Public Meetings. (London: George Philip and Son, 1894.) Presented by the Publishers.

Unwin, William Cawthorne, F.R.S.—On the Development and Transmission of Power from Central Stations, being the Howard Lectures delivered at the Society of Arts in 1893. (London: Longmans, Green and Co., 1894.) Presented by the Publishers.

Whiteley, R. L.—Organic Chemistry: the Fatty Compounds. (London: Longmans, Green and Co., 1895.) Presented by the Publishers.

ournal of the Society of Arts.

No. 2,230. Vol. XLIII.

FRIDAY, AUGUST 16, 1895.

l communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

By an Act of Congress, passed in August, 94, the President of the United States was ithorised "to signify to the Governments of e several countries duly represented at the 'orld's Columbian Exposition, and to their ading official representatives thereat, the ateful appreciation of the Government and ople of the United States of America for their lued contributions to the success of said xposition, and for their friendly participation the solemnities of an occasion designed to mmemorate one of the most important events human history."

Under the authority of this Act, the resident has sent to the Commissioner each country represented at Chicago a ecial diploma, signed by himself, and by e late Mr. Gresham, the Secretary of State, id sealed with the United States seal. The presentatives of Great Britain who have ceived this recognition are the Attorney-eneral (Sir Richard Webster, M.P.), the airman of the Royal Commisson, and Sir enry Trueman Wood, its secertary.

Proceedings of the Society.

CANTOR LECTURES.

ECENT AMERICAN METHODS AND APPLIANCES EMPLOYED IN THE METALLURGY OF COPPER, LEAD, GOLD, AND SILVER.

By James Douglas.

Lecture II.—Delivered April 29, 1895.

Iechanical Calciners and Chlorination Processes.

Mechanical Calcining Furnaces.

No metallurgical operation, as performed by and, is more tedious than the calcination of ore, and none, comparing the bulk of material handled with the amount of energy expended, is more wasteful of labour. Calcination enters, with the few exceptions, as a step in every metallurgical process, and as the improvements looking to economy of labour are in the line of mechanics rather than of chemistry, a larger number of inventors have exercised their talent in devising appliances for its performance than if chemical knowledge were required. Three types of mechanical furnaces are in general use in the United States, among which the choice is determined in a measure by the service required :—

1. Rake furnaces.
2. Shaft furnaces with long drop.
3. Cylinder furnaces.

Rake Furnaces.

Of the rake furnaces, one of the oldest is not an American invention. It was patented in England by Peter Spence, and was one of the latest of the many inventions which technical science owes to his busy life. As originally designed it was a four-hearth furnace, the upper hearths discharging on to the lower through slots in the arch at alternate ends. The ore is moved forward now, as in the original furnace, by ploughs attached to a long frame, which issues completely from the furnace during each forward and backward journey, thus securing a sufficient cooling period for the frame; while the ploughs cool in an accumulation of ore at the extreme end of the floors, where it is protected from the draught and from active combustion. The Spence furnace as now built has been improved in every structural detail, so as to be as durable as such a piece of mechanism exposed to heat can be made. It has not found favour in the Western States, but is extensively used for burning pyrites' fines in Eastern acid works. The Alaska-Treadwell Company used it for roasting their sulphurets, preparatory to chlorination, but have abandoned it in favour of the hand furnace. The Keller furnace, which will be described later, is a modified Spence, but so modified as to be essentially a new design.

The most popular rake furnaces are modifications of a furnace introduced 25 years ago by O'Hara, under patents issued to Yerrenton. In its primitive form it received scant adoption, on account of defective design and consequent uncertainty of operation. The original furnace was built with one hearth 80 feet long. The

ploughs were secured to triangular cross-bars attached to an endless chain; the chain, dragging through a groove in the centre of the hearth, and the ploughs scraping on the bottom caused such excessive wear of both the hearth and the mechanism, that the furnace was a practical failure. It has, however, undergone modification after modification, till transformed into the present Brown-Allen improved O'Hara, and into several circular rake furnaces. The Brown-Allen O'Haras, as used in Butte, are constructed with two hearths, 100 feet long by 9 feet wide, and four fireplaces, two on each side of the upper hearth. They roast from 45 tons to 50 tons per day of concentrates, reducing the sulphur contents for furnace work to six per cent. Where applied to chlorodising silver ore, as at the Cortez Mine, Nevada, they handle 30 tons, but do their work most effectively. In some furnaces, the lower hearth is extended beyond the limits of the furnace, to serve as a cooling floor. When employed to roast, preparatory to smelting, the floor of the lower hearth may terminate in a hopper, whence the accumulated hot ore drops into reverberatories. The mechanical defects of the original O'Hara furnace have been remedied by dividing the hearth into three compartments. The central compartment constitutes the roasting area. The side compartments, into which no ore can enter, are provided with rails, on which carriages are drawn by endless chains. To these carriages are fastened arms, which extend through slots in the opposite partitions to the centre of the furnace; and to the arms are attached the ploughs which agitate and propel the ore. The rails on which the carriages travel extend beyond the furnace, to allow the cooling of the carriage, the chain, and the rake, as they travel towards the pulleys, by which motion is communicated to them, and over which they are carried from hearth to hearth. Double doors, hung at each end of the hearth, admit as little air as possible, while allowing the rows of ploughs to issue and enter.

Mr. R. Pearce, of Argo, has designed a furnace, several of which have been erected at his own works, and which have been used with much favour elsewhere. In the Pearce turret furnace the machinery, which imparts a revolving motion to radial arms and ploughs, is placed within the cool open space left by a large circular hearth. The arms are of hollow tubes, through which is forced air that can be thrown upon the surface of the ore at a certain stage of the roast, thus cooling the arms and ploughs, and accelerating oxidation. The fireplaces supply extraneous heat. The hollow space below the hearth is utilised as a dust-chamber. Furnaces of this type are now built with hearth above hearth, thus prolonging the roasting where complete oxidation is required. Mr. Pearce has supplied me with the following information. He says:—

"The turret roasting furnace having been in con- stant operation at these (Argo) works for a period o about three years, I have had ample opportunitie for testing its capacities on ores and mattes o different kinds. The following results were obtaine from runs of sufficient quantity of material to ensur their correctness, and they are certainly very con servative. To test the capacity of the furnace fo roasting, I made use of Gilpin county tailings con taining 79·5 per cent. pyrite, representing 42·1 pe cent. sulphur. Of this material the furnace was abl to roast 9·8 tons per 24 hours down to 0·22 pe cent. sulphur, at a cost of $1·15 per ton.

"Pyrite, containing little or no foreign elements carrying about 46 per cent. sulphur, has been roaste to 4·46 per cent. sulphur, at the rate of 14·76 ton per 24 hours, at a cost of 71 cents per ton.

"An ordinary mixture of ores, containing pyrit with from 20 to 30 per cent. silica, may be roaste to 4·75 per cent. sulphur, at the rate of 16 tons pe day, at a cost of 70 cents per ton.

"Matte, containing lead to the extent of from 10 t 15 per cent., and 30 to 35 per cent. copper, has bee roasted to 6 per cent. sulphur at the rate of 13 ton per day, at a cost of $1·00 per cent."

In connection with matte roasting, Mr Alfred Ropp, Superintendent of the Selb Smelting and Lead Works, in California, write as follows:—"We have roasted mainly matt from the blast furnaces in the Pearce roaste containing from 8 to 12 per cent. lead, an have had no trouble whatever in roastin 14 tons per 24 hours down to 4 per cen sulphur.

The Colorado Smelting and Mining Com pany, of Butte, claim that they calcine to 6 pe cent. of sulphur, 15 tons per day in a Pearc furnace at 65 cents, and 30 tons in a doub hearth Pearce furnace, labour being $3·00 p day, and coal $3·50 per ton.

Still another furnace has been a recent ou growth of the O'Hara, the brown horsesh furnace. It is also circular in form, the radii from the centre of the open space to the cent of the hearth being 28 feet. The hearth about 150 feet in length along the radial lin and 8 feet in width, and the open spa between the cogs of the horseshoe is abo 20 feet. The rake arms are clutched to a endless chain, much on the principle of th

cable car, and, by an automatic device, when a rake reaches the open space, it is dropped and allowed to cool till the next rake reaches the same spot, and is released, when the cool rake takes its place. The furnace is working admirably on zinc ores, and is giving satisfaction at Argentine, Kansas, in even roasting copper-lead matte for the leaching works.

At the Parrot Works, Butte, Mr. H. A. Kellar has for years past been modifying the original Spence rake furnace, with progressively better results. He has supplied me with the following Table, showing from his actual working returns the steady reduction in the cost of operation, not only as compared with hand-furnace work, but of one mechanical furnace compared with another:—

	Reverberatory.	Old Spence.	Improved Segmental.	Improved Rectangular.
Cost of construction at Butte	\$4,500·00	\$2,500·00	\$8,500·00	\$10,000·00
Yearly running time	360 days	320 days	340 days	360 days
Daily gross capacity	10 tons	7 tons	30 tons	43 tons
	dols.	dols.	dols.	dols.
Labour for 24 hours (furnace and tramming)	9·33	4·38	11·50	9·95
Fuel	10·00	none	1·00	2·50
Repairs and shutdowns	1·00	3·00	2·50	1·25
Power	none	2·50	1·00	1·00
Sinking fund (6 per cent.)	·79	·42	1·42	1·67
Total direct expense	21·12	11·30	17·42	16·37
Cost per ton	\$2·00	\$1·91	\$0·58	\$0·41

What Mr. Kellar calls his segmental furnace is a four-hearth circular calciner, with a drying floor on the roof of the topmost hearth. Each circular hearth can be divided into two or more segmental furnaces, by brick piers rising from the foundation to the roof of the topmost hearth, such piers not only giving support to the structure, but affording passage to a hot or cold air supply, as may be desired, for the hearth. The rake arms are tubes screwed to a vertical tube, through which air is forced, and made to issue through openings in the rakes, and the whole is given by suitable machinery a slightly oscillating motion, which agitates the ore very effectively. By other mechanical devices, the rakes are made to travel the full length of the segmental furnaces into which the circle is divided; then rotated a quarter turn, to liberate them from the ore, and returned, by reversing the whole hollow frame, to the receiving end of the hearth. To prevent the falling ore lodging on the rakes of the hearth below, the rakes occupy alternating positions on successive floors, but are always within the furnace. The cooling is effected by the passage of air through them. Keller has designed also a duplex rectangular four-hearth furnace, operating on the same general principles as his segmental furnace, above described. The rectangular space between the parallel rectangular furnaces holds the machinery. Another modification of the duplex rectangular has been invented by Mr. A. H. Wethey, of the W. A. Clark Reduction Works, Butte, in which the rakes travel in one direction, and are moved by chains, as in the different varieties of the O'Hara furnace. Details of construction of these duplex rectangular furnaces are not given, as patent applications are still pending.

Inventive activity in the designing of mechanical calciners in America at present undoubtedly runs in the direction of rake furnaces, and tends rather towards complexity than simplicity. With ores not liable to sinter all such furnaces can, of course, be worked with much less strain on the machinery, and, therefore, comparatively less wear and tear than when treating such a substance as copper matte, which is liable to stick to the hearth, and either injures the ploughs or tears up the brick floor in its removal. There is, therefore, an absence of concurrence of favourable opinion on the part of those who use these mechanical furnaces, due in part to the class of material treated, in part to the greater or less skill and care with which the furnace is handled; but there can be only one opinion as to their utility when applied to suitable ore provided always they be kept in perfect repa

and watched with sedulous anxiety. The most palpable metallurgical defect is the excess of air admitted through the long slot, by which the arms enter the furnace, or through the doors as they open to allow the passage of the rakes. The slot is always protected by self-closing doors or shutters, which, nevertheless, admit a wasteful quantity of air. Were it possible to overcome this structural defect, this type of rake furnace would on highly pyritiferous ore be self-burning.

Of the Brunton type of revolving hearth furnace I know of only two examples. One is in use at the Haile gold mine in North Carolina, and finishes the roast of gold concentrates which has been nearly completed in a hand furnace preliminary to chlorination. The other was devised by Professor W. P. Blake, and has been applied to the roasting of blende and pyrite near Shullsburg, Wisconsin. The roasting hearth is a circular terraced table 16 feet in diameter. As it revolves slowly the ore is agitated and thrown from terrace to terrace by ploughs secured in the roof. The ore is fed continuously to the upper terrace through an opening in the apex of the conical roof. The heat to maintain oxidation is derived more from super-heated air than from the direct flame in the fireplace. The aim is to maintain a temperature under such control that the *marcasite*, which is one of the constitutents of the ore, shall be oxidised so as to facilitate its separation by mechanical means from the blende, another constituent of the ore, which is left unaltered—a delicate operation. which Professor Blake claims he is able to effect with consistent regularity.

Shaft Furnaces.

The only shaft furnace which has maintained a position of prominence is that invented by Mr. C. A. Stetefeldt. As far back as 1864, Stetefeldt patented a shaft furnace with terraces after the general design of the Gerstenhofer, but subsequently he omitted the terraces, and insreased the height of the stack. As now constructed, the furnace consists of a vertical shaft 48 feet high, tapering from 6 ft. by 6 ft. at and below the fireplaces, to 4 ft. 6 in. by 4 ft. 6 in. at the top, with an effective drop of 37 feet, and a total drop of 48 feet. An inclined returning tube, which has a reversed taper, carries the dust escaping from the main shaft through the flame of an auxiliary fireplace or gas-jet into a horizontal tube provided with hoppers, and thence into a dust chamber. Two fireplaces near the base of the main shaft, and a third at the bottom of the returning tube have, in the more recently erected furnaces, been replaced by combustion chambers, where gas from Taylor producers is burnt. An essential feature of the furnace has always been the admirably-contrived and adjusted feed, which can be accurately regulated to the ore under treatment. Full details of construction have been recently published in a paper by Stetefeldt to the "Transactions of the Federated Institution of Mining Engineers," part I., vol 6. The capacity of the furnace as a chloridiser depends, of course, on the constitution of the feed. It ranges from 70 tons to 100 tons per diem. It is nowhere used except to chloridise finely-ground ore mixed with salt, though experiments, made on raw roasting of Ontario ores, suggest a possibility of eliminating salt in the roasting of certain base silver ores before amalgamation or lixiviation. If the ore be very base, the reaction is merely started during the rapid fall of the particles through the shaft, and the chlorination proceeds on the cooling-floor, if the ore be left in heaps, as long as the heaps retain heat sufficient to maintain the reaction. Stetefeldt gives some very interesting data on this subject in his paper read before the American Institute of Mining Engineers, in February, 1894. A sample of Lexington ore butte showed an increase of chlorination of the silver contents from 47·10 to 90·8 per cent. during only 12 hours cooling, and peroxidation of the iron was evinced by a decrease in magnetic oxide from 17·5 per cent. to 2·3 per cent., and a corresponding increase in ferric oxide. Whether the furnace can be used as an effective oxidiser is still undetermined. Stetefeldt thinks it can, and takes issue to the conclusions drawn from some hasty experiments made by Terhune. One would think that while the short exposure to heat might be sufficient to oxidise ore very low in sulphur, it would hardly suffice for highly-sulphuretted mixtures. Moreover, continuous oxidation would not proceed in the quiescent mass after roasting as effectually as chlorination proceeds under like conditions through the decomposition of salt. As a chloridiser of burnt pyrites, the furnace might be found to be very economical, and should be tried. The very short exposure of the ore to heat, it is claimed, reduces loss of the precious metals, and renders the silver more soluble when leaching with hypo is employed.

The fineness to which the ore must be ground before roasting is subject to no general rule,

but depends on its character. Stetefeldt gives the following results of experiments on Ontario ore :—

Mesh of Screen on Battery.	Tons crushed in 24 hours.	Rate at which the St. fur. was fed in 24 hours.	Salt used.	Silver extracted by Russell process.
	Per stamp.	Tons.	Per cent.	Per cent.
20	$2\frac{3}{4}$	55	12·5	97·0
16	$3\frac{1}{2}$	70	12	97·1
10	$4\frac{1}{2}$	94	14	93·4
6	$6\frac{1}{3}$	126	8	91·9

These results will be confirmed by the experience of many metallurgists. A uniformly compact base ore it is unreasonable to suppose would be oxidised or chloridised by almost momentary exposure to heat, if ground coarse, but quartzose ores, which carry the gold and silver minerals as films on the cleavage planes, are generally ground necessarily fine both for milling and for roasting. I have extracted, by milling, as much free gold from a sulphuretted gold ore, passed through a screen with ten holes to the inch, as when crushing through thirty holes to the inch. Experience can alone determine the minutiæ of treatment for any ore. The great advantage of coarse crushing in the case of a gold ore yielding both free gold and auriferous sulphurets is, that jigs can be used, partially at least, in the concentration of the latter.

Shelf furnaces have never been popular in the United States. At La Salle, Illinois, 25 years ago, a huge Gerstenhofer, 90 feet high, was built to roast blende, but to-day there is not a single furnace of that type in operation.

Revolving Cylinder Furnaces.

Of this class of mechanical calciners, two designs have been largely used; the Brückner, with intermittent feed and discharge, and the White-Howell, with continuous feed and discharge. Brückner's first patent was issued in 1866, long after the black ash furnace of Elliott and Russell, as pointed out by McTear, had come into use in this country. Brückner's specification describes a horizontal cylinder furnace, suspended by chains from revolving sprocket wheels. The ore was moved backwards and forwards by spiral shelves built into the lining. The specification contains the following comparisons, especially interesting as exhibiting the cost of chloridising in a hand furnace at that day :—

Roasting 5 tons of Ore in 24 hours in 4 Reverbatory Furnaces.

	$
For 12 men $3·50	42
For $3\frac{1}{2}$ cords of wood, at $12	42
For 500 lbs. salt	25
Total	$109

Cost per ton, $21·80.

Roasting 5 tons of Ore in 2 Brückner Furnaces.

	$
For 1 man	3·50
For 2 cords of wood at $12	24
For 500 lbs. salt	25
Moving power, 7 per cent. of a 300 horse-power engine	3·50
Total	$56·0

Cost per ton, $11·20.

To-day the Brückner cylinder, as used in the smelting works of the Anaconda and the Boston and Montana Companies in Montana, is a cylinder 18 feet long by 8 ft. 6 in. in the centre, tapering slightly to the ends, one of which admits through an opening the heat from a fixed or moveable fireplace. At the other end an opening of the same size permits the escape of the gases to the chimney. The periphery of the cylinder is provided with four openings, closed by drop doors; is lined with brick, none of which protrude as lifters, and is encircled by friction rings, which rest upon four carrying rolls. The weight of the furnace, lined and charged, is about 60,000 lbs. The speed varies with the ore under treatment. In roasting Butte concentrates, the furnace makes one revolution every three minutes; whereas, at the Germania Lead Works in Utah, ores carrying galena are successfully roasted, by moderating the agitation to as slow a movement as one revolution in 40 minutes. In operating the furnace at the smelting works at Butte, a charge of from 9 to 12 tons of ore —generally concentrates—is dropped from hoppers, previously filled, through two of the doors, into a hot furnace, with the fireplace attached. The cylinder is then revolved, and the fire is maintained in the fireplace, which is left in position until the ore is thoroughly ignited. The fire-box is then removed and not replaced till towards the close of the operation, when the roast is exposed, just before drawing, to a brisk heat. The time required to reduce the sulphur contents to 7 per cent., which gives a matte in the reverberatories of between 50 and 60 per cent., is about 24 hours, though it sometimes reaches 30 hours.

The power expended is between 4 and 5 horse-power, and the fuel consumed one ton of Rock-Spring coal, a good Wyoming lignite, per day. The full charge is conveyed while hot to the reverberatories, whose capacity is thus notably increased, rising to from 40 to 60 tons of charge per day. Herein lies the greatest advantage of the Brückner over the furnaces of the O'Hara type, whose roasted ore is pushed off the roasting hearth by the travelling ploughs so slowly that even when received in hoppers it loses temperature to a wasteful extent, before sufficient has accumulated to make a smelting charge. In the Brückner the ore revolves slowly on the bottom and ascending side of the cylinder, while the current of air passes directly from opening to opening in the ends and comes but imperfectly into contact with the roasting ore. To accelerate the oxidation jets of air are in some furnaces forced upon the surface of the burning ore through a water-jacketted perforated pipe, known as the Clarke Oxidising and Desulphurising Apparatus.

The operating cost of calcining in both the O'Hara and Brückner type of furnaces, if confined to the items of fuel and labour, would be very light and easily calculated. The ambiguous cost is that of repairs and replacement, which are heavy if the furnace house be dusty, or care be not taken to protect the wearing parts from sand. The Brückner has displaced hand furnaces in the works of both the Anaconda and the Boston and Montana Companies of Montana. The new smelting works of the Anaconda Company are equipped with no less than 106 of these cylinders.

The only other cylinder furnace which has received wide adoption is the White-Howell, and it is being used more for chloridising than for merely oxidising. The White-Howell is to all intents and purposes the Oxland Cylinder so well-known in England. It is lined with bricks, four rows of which on end form as many lines of lifters. The White-Howell differs from the White in that the section nearest the fireplace exceeds in diameter the rest of the furnace and is alone lined with fire-brick. The iron of the other sections is exposed, and spiral shelves are cast on their inner surfaces. In the erection of the White-Howell, Mr. Howell, who is now connected with the Broken Hill property, combined with his cylinder some of the features and advantages of a shaft furnace, by elevating it above the fireplace and showering the ore, as it escapes from the furnace, into the flue through which ascends the flame of the fireplace.

A comparison can be made between the Stetefeldt, Howell, and Brückner furnaces only as chloridisers. This was done by Ellsworth Daggett in an exhaustive paper on the Russell process. He arrived at the following results from the working of the several furnaces at different works, where, however, the ores were sufficiently similar to yield adequately reliable data.

1. As to capacity. The Stetefeldt has a capacity of 70 to 100 tons per day, while that of a Howell rarely reaches 40, a Brückner 20 and a reverberatory 10 tons per day.

2. The Stetefeldt furnace leaves the roasted ore in a better condition for rapid and thorough leaching, as illustrated at Yadras and other places; the effect of a long-continued rolling motion, as in a Brückner, not only often results in the formation of balls, but leads to a hardening of the leaching charge as soon as water or solution is turned upon it. This was not found to be the case with ore roasted in a reverberatory or the Howell furnace, and never has been the result of Stetefeldt roasting.

3. The amount of fuel required for roasting in a Stetefeldt is about one-tenth of a cord of wood per ton of ore, while for the Howell it is from one-quarter to one-third, and for the reverbatory from one-sixth to one-quarter of a cord.

4. The amount of power required to run a Stetefeldt is only that necessary to shake the screens at the top of the shaft, which is probably not more than one-thirtieth that required to run a Brückner, or one-fifteenth of that required for a Howell furnace per ton of ore capacity.

5. The average extraction by leaching from ore roasted in a Stetefeldt is 4·2 per cent. above that when the ore is roasted in the Howell; 4·8 per cent. above reverberatory roasted ore, and 6·9 per cent. above that roasted in the Brückner.

I have for some years used a cylinder furnace of my own designing, which possesses some novel features, and is serviceable, within a limited range. One reason why continuous feed cylinder furnaces are so little used for oxidising is because the atmosphere within them alternates between oxidising and reducing conditions with the varying state of the fire, when solid fuel is used. To obviate this, I connect the fireplace and dust-chamber by a flue, supported concentrically in the cylinder by four or more lines of supporting

Operations of Roaster for One Month.

Date.	Raw Sulphide Ore per Cent. Cu.	Raw Ore, per Cent. Sulphur.	Roasted Ore, per Cent. Sulphur.	Sulphide Ore delivered to Roaster.	Coal used at Roaster.
Dec. 1	9·6	27·7	5·6	13,150	1,035
2	9·4	27	5·7	21,150	—
3	11·6	27·8	6	19,650	—
4	9·4	26·5	4	23,300	595
5	8·6	26·8	5 2	24,000	—
6	9·4	26·2	5·4	25,700	195
7	9 6	27·4	4·2	24,800	—
8	11·6	25	4·5	24,100	1,175
9	12·4	24	6·2	23,200	835
10	13·4	25·6	4·8	24,850	1,730
11	9·4	28·8	5·1	24,450	—
12	10·4	26·8	4·5	24,650	—
13	8·6	29	4·2	21,900	—
14	7·8	26·8	4·5	23,600	1,367
15	7·6	25·3	5·6	24,600	2,655
16	7·4	27·4	4·2	22,700	—
17	5·6	24·6	5·8	23,600	—
18	7·9	24·6	6·2	16,250	1,890
19	8·4	25	7·3	17,600	2,700
20	7·8	26·5	4 9	26,600	2,895
21	9·1	26·8	5·4	25,650	—
22	9·5	26·8	5·5	21,850	—
23	8·9	28·4	4·9	25,300	—
24	8·5	27·3	4·2	25,000	—
25	10·4	25·6	5·2	17,100	820
26	7·5	27·4	4·2	29,050	930
27	8·3	26·8	4·3	23,300	2,655
28	7·5	28·4	4·1	26,750	1,925
29	9·5	22	5·3	23,000	1,620
30	8·3	21·5	6	20,500	616
31	9·6	22·7	5·6	8,650	—

The rate of speed varies from one revolution in three minutes to one revolution in ten minutes, with the varying character of the ore under treatment. Owing to the thorough and frequent agitation of the ore a great deal of dust is made. A dust chamber is therefore a necessary adjunct, but the heat in the fourth compartment of a dust chamber, when the furnace was running on pure pyritic concentrates, was over 600° Fahr., a temperature sufficiently elevated for effective working of a Glover Tower.

tiles. Slight intervals are left between contiguous tiles of the same row, through which the ore falls from compartment to compartment. The cylinder becomes thus a revolving shelf burner. The central flue may be built of cast iron or of tiles. I have found that, if the ore contains 27 per cent. of sulphur and over, it burns itself, the large mass of brick, or brick and iron work, within the cylinder, stores, and equalises the emission of heat. If the sulphur contents fall below that per-centage, the fireplace must be attached, and heat transmitted through the central flue. The applicability of the furnace is curtailed by the tendency of fusible ore to sinter in the great heat generated at a few feet from the feed end, and by the difficulty of reaching and removing accretions, owing to the contracted space of the compartment. A register in the discharge end of the furnace controls the admission of air, and enables sulphurous acid gas of any desired strength to be generated. The Table in the previous column illustrates the range within which the furnace is self-burning.

I know of no cylinder furnace in the United States comparable, either in excellence of construction or thoroughness of work done, with the magnificent 80 foot cylinders used at the Cape Copper Company's Briton Ferry Works for the dead roasting of their white metal, preparatery to its conversion into refined copper by Nicholl's direct method.

Mr. R. P. Rothwell, when using a cylinder furnace at the Dolores gold mine, Ontario, found that by extending the length of the lifters until they met in the centre of the cylinder, and by thus subdividing it into four compartments, he increased almost four-fold the effective capacity of his furnace.

Gold Chlorination.

Auriferous sulphurets became early in the history of Western mining as puzzling a nuisance as they had long been to the miner in the Southern States. But the puzzle was soon solved by the energetic inventive Western man. As early as 1856 he applied the Plattner chlorination process to the sulphurets of Grass Valley in California, where, fuel being costly and lead and copper scarce, the smelting method was precluded. Chlorination, carried out on the same system, is still practised in Grass Valley and in many points in Amador, Calaveras, and other counties in California. In Colorado, Utah, and Montana, on the other hand, lead or copper ores being abundant and fuel less expensive than on the Pacific Coast, gold chlorination has been but little practised, refractory ores being subjected to furnace treatment. As most of the auriferous sulphurets of the Southern States are in a quartz or slatey gangue, this condition has there determined the application of a chlorination

method. As Dakota is not in a smelting area, and the gold deposits of Deadwood have become more and more sulphuretted as depth has been attained, chlorination has been resorted to for their treatment, and for that of the Potsdam sandstone ores; and novel appliances have been introduced to overcome the difficulties of filtering the slimy and more or less arenaceous pulp. Chlorination is also applied to the concentrates of the Alaska Treadwell mill on Douglas Island, Alaska.

At Grass Valley, and elsewhere in California, Plattner's plans are still closely followed. The roasting is done in hand furnaces of different designs, some with three hearths in storeys, others with their hearths in succession. Of these, some have a drop of several feet between the hearths. The drop at the Lincoln works of Amador county is 7 feet between hearths. The chlorine is generated in a separate apparatus, and the gas, introduced below the false bottom, permeates the moistened mass. There are no departures from established practice or ordinary apparatus requiring extended notice. Most of the works in California are small, and treat custom ore, and the charges are much above the cost at which chlorination is effected in the Southern States and Dakota. When silver sufficient is present to warrant an extra operation in saving it, the pulp in the vats, after the gold has been extracted, is leached with hyposulphite of soda. The extraction of both metals simultaneously by chlorinated brine seems not to have been anywhere practised.

The barrel chlorination of gold ore was first proposed in the United States by Dr. Mears, of Philadelphia, in 1877. He forced chlorine gas through the hollow trunnions of the barrel, and by a goose neck discharged it into the pulp. He found that with a pressure of two atmospheres and a temperature of 40° C. the chlorination was most perfect and rapid. Mr. A. Thies, who practised the Mears' process at the Bunker-hill Mine in California, adopted a suggestion made in one of the Mears' specifications to insert the chlorine generating chemicals with the roasted gold ore in the barrel itself; and he has worked up this modification of the Mears' processs so skilfully as to warrant its receiving his name. The result of Mr. Thies's operations at the Haile Mine, in N. C., in 1893, in point of cost of treatment and thoroughness, exemplifies the progress made through increase of experience, for in the Paper laid before a meeting of the American Institute of Mining Engineers, in 1888, by Mr. W. D. Phillips, the cost of treatment is stated to be at that date for roasting, \$2·18; chlorination, \$2·66; total \$4·84.

The actual cost per ton of concentrates in 1893 was only \$3·02. In a recent communication from Mr. Thies, he gives me the details of cost for 1894, which, owing to the smaller quantity treated, was slightly above that of 1893. He says:—

"I chlorinated in 1894 2,014 tons concentrates which required for roasting 732 cords wood at \$1·50 per cord. For generating chlorine, &c. making ferrous sulphate, we used 33,011 lbs. sulphuric acid, 66·0 B at 1·5 cents. laid down, and 15,400 lbs. of chloride of lime at 3 cents. per lb. We expended for labour \$456,652 to roast and chlorinate the 2,014 tons, which will show the labour cost portion, with \$2·31; adding to this, not quite $\frac{3}{8}$ of a cord of wood for roasting a ton, with 55 cents., 24 cents. for sulphuric acid and 21 cents for chloride of lime, we have a total of \$3·31 for roasting and chlorinating one ton of concentrates. These figures are absolutely true; and if my production of concentrates continues for 1895 as at this writing, I will reduce chlorination below \$3·00. By adding 12 cents per ton for steam and administration you have a grand total of \$3·43. Calculating the cost on the tonnage of ore milled, I get $19\frac{5}{10}$ cents for chlorination."

The difficulty of causing a solution to percolate through slime, even of iron oxide, still more when the slimes are arenaceous, has been the greatest impediment in the way of leaching. The difficulty is aggravated when the ground ore is discharged from an agitating vessel and settles on a filtering bed. The heaviest particles sink to the bottom and the slimes form an almost impervious layer above. The concentrated sulphurets of Dakota have presented peculiar obstacles to treatment in that direction, which, however, have been mitigated by the addition to the chlorinating barrel of an asbestos filter, through which the solution of chloride of gold is forced (after chlorination has been effected in the barrel, by the Thies process), by pumping the barrel full of wash water under a pressure of 40 lbs. To arrest any slimes which escape through the barrel filter, the solution is forced through a closed subsidiary filter vat into the precipitating vats. At the Golden Reward Mill the precipitation is effected not by sulphate of iron, but by sulphuretted hydrogen after all excess of chlorine has been converted into hydrochloric acid by the injection of sulphurous acid. The roasting of the freer ores is done in White-Howell furnaces, of the baser

ores in Brückner cylinders. The cost is given by Mr. J. D. Rothwell, in September, 1891, as follows, on a treatment of 1,315 tons:—

	$
Milling	1·44
Roasting	1·37
Chlorination	1·65
Office salaries, &c.	0·37
Construction and repairs	0·21
Total	$5·04

It is said that the cost has since been reduced, but I have no accurate figures.

Bromine has not yet supplanted chlorine as a solvent of gold, though it was claimed that in the mill at Rapid City, Dakota, a saving was effected of 60 cents. per ton in the cost of re-agents, and yet with satisfactory results as to extraction. When using bromine, barrels were used, but the solution of gold and pulp were discharged into a filter vat with a tight cover and closely adjusted bottom, which latter, after the auriferous solution had been forced through the filter, and the exhausted pulp dried by air-pressure, was lowered by a jack and removed with the finished charge.

The cyanide extraction of gold has not been widely practised in the United States, though it is being successfully used in several localities. Where its use is contemplated on the Potsdam gold ores of Dakota, a mill for its application has been designed on the general lines of the chlorination mills, with barrel filtration under pressure.

Chlorination of Silver Ores.

The line of demarcation between free milling and refractory silver ores is much more pronounced than between the same classes of gold ores. Comparatively few silver ores can be treated advantageously by pan amalgamation without preliminary roasting. The tailings always yield valuable products to concentration, chlorination, or smelting. Amalgamation, after furnace chlorination, was in the past the method applied to the most refractory silver ores where smelting was not practised. All the ores of Utah were thus treated till the Marsac mill adopted the Russell modification of the Patera leaching method. There the success was so pronounced that now, where smelting is not clearly indicated by the presence of valuable quantities of lead and copper, the choice lies between pan amalgamation and the Russell process, for the evidence is conclusive as to the advantage of the Russell process over simple hypo-leaching.

The difference between the Washoe and the treatment of base silver ores by pan amalgamation, consists in the artificial chlorination of the silver in the base ore, by roasting with salt. The furnaces used for that purpose, and the preference for one over another, have been referred to in a previous part of this lecture. The machinery, and the steps of the process, apart from the salt roasting, are the same as for the Washoe process. The Patera, or Kiss Patera process, pure and simple, is, and has been, practised in many small works, though it has not been widely used in important establishments; but the improvements of the method by Mr. E. H. Russell have led to its adoption in large works, both in Mexico, and in the United States.

The experience that copper salts decompose certain unstable silver compounds has been taken advantage of somewhat blindly in the Washoe, and (with precise knowledge of the reactions between sub-chloride of copper and such silver compounds) had been employed by Kröhnke in his beautiful process, as practised at the establishment of Escobar and Ossa, at Copiopo and elsewhere in Chili. Russell, on the other hand, uses a double salt of hyposulphite of soda and copper (the salt of Lenz), made by mixing solutions of hyposulphite and bluestone, whose composition is expressed by the formula—

$$2\,Na_2\,S_2\,O_3\,3\,Cu_2\,S_2\,O_3 + 5\,Aq.$$

It is sparingly soluble in water, but dissolves freely in a solution of hyposulphite of soda. It is not only more active than hypo in its solvent properties over argentic chloride, but it attacks native silver and silver sulphuret, and antimonial and arsenical sulphurets of silver, as well as gold, the latter, however, feebly. But so energetic is its action on silver compounds, as to permit of the use of less salt in the furnace charge of such ores, and of their exposure to a less prolonged and perfect roast. In some cases, refractory silver ores can be treated raw. The extra solution, as Russell calls his double salt, may be made with cuprous chloride. In that case, as pointed out by Stetefeldt, no hyposulphite of soda is lost in the reaction; but the cost of cuprous chloride militates against its use. The following formulæ express the reactions in both cases—

$$13\,Na_2\,S_2\,O_3 + 6\,Cu\,SO_4 = 4\,Na_2\,S_2\,O_3\,3\,Cu_2\,S_2O_3 + 6\,Na_2\,SO_4 + 3\,Na_2\,S_4\,O_6$$
$$7\,Na_2\,S_2\,O_3 + 3\,Cu_2\,Cl_2 = 4\,Na_2\,S_2\,O_3\,3\,Cu_2\,S_2\,O_3 + 6\,Na\,Cl.$$

If lead be present Russell precipitates it from the sodium hyposulphite solution as carbonate by sodium carbonate. Were calcium sulphide used for precipitating the silver, a calcium salt would be precipitated, on which account, as well as for other reasons, sodium sulphide is preferred.

Another advantage possessed by the process is that caustic lime in the charge is less deleterious when using cuprous hyposulphite than when using the single salt. In the Russe[ll] process as in the Patera, the hyposulphite [is] regenerated during precipitation, and t[he] precious metals recovered as sulphides*. Th[e] wide range of its applicability is demo[n]strated by the divers characters of t[he] ores, as given in annexed Table, publish[ed] by the Russell Company, at the two mill[s] where it has been longest and most exte[n]sively used :—

Name of Ore.	Silica.	Carbonate of Lime.	Iron.	Zinc.	Lead.	Sulphur.	Barium Sulphate.	Copper.	Arsenic.	Magnesi[a].
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cen[t].
Yedras	25·0	46·5	9·8	—	—	12·5	—	—	2·5	—
Park City ..	76·6	2·0	1·6	5·3	3·5	0·7	—	0·4	—	—

It has also been demonstrated, in the case of various ores which have been treated in this process, in amounts varyi[ng] from 1,000 to 40,000 tons, that the zinc and sulphur contents of ores may reach as high as 20 per cent. each, lead 15 per cen[t.] pyrites 40 per cent., barium sulphate 45 per cent., and carbonate of lime 45 per cent., without materially increasing the co[st] of treatment or decreasing the per cent. of gold and silver extracted by the Russell process.

As usually practised the salt roasted ore is first leached with water, to remove the soluble salts; then with ordinary hyposulphite solution. This is succeeded by the "extra solution" of the Russell process, containing 1 per cent. of bluestone in addition to the hyposulphite of soda of the ordinary solution. Before turning on the wash water treatment with both ordinary and extra solutions may be repeated. The strength of the stock solution is maintained at from 1·6 per cent. to 1·9 per cent. in hyposulphite of soda, and all solutions are kept at a temperature of from 90° to 120° Fahrenheit.

Tables of comparison of the Russell and ordinary Kiss-Patera processes applied to Yedras ores, during long runs, show a gain for the Russell of 16·5 per cent. in value recovered. There have also been carefully tabulated statements published of the results of Russell lixiviation at the Marsac mill, which was converted from an amalgamation mill, as compared with roasting and amalgamation at the Ontario mill, both working on ores from the same lode and of the same composition. The comparison is interesting as giving the cost not only of roasting and lixiviation, but of roasting and amalgamation, where conducted on a large scale, and with the experience gained by many years of practice :—

* C. A. Stetefeldt, "The Lixiviation of Silver Ores." 1888. New York.

COMPARISON OF ONTARIO AND MARSAC.

(From Companies' Annual Report.)

Mill Expenses.

	Cost per ton of ore.	
ONTARIO—Amalgamation.		
Milling	$8·93	
Product Expense	1·23	
	$10·16	
MARSAC—Russell Process.		
Milling	$6·27	
Product Expense	$1·23\frac{1}{2}$	
	$\$7·50\frac{1}{2}$	
Total difference in Mill expenses		$2·65
Actual Extraction of Silver. (*Raw Ore.*)		
ONTARIO.—Actual Mill Extraction	91·0	
MARSAC.—Actual Mill Extraction	91·57	
Difference in Mill Extraction.	0·57%	
Difference in Mill Extraction for 39·10 ozs. ore		$0·21
Actual Extraction of Gold. (*Raw Ore.*)		
ONTARIO.—Mill Extraction. Gold Realised	$0·0	
MARSAC.—Mill Extraction, Gold Realised per ton ..	$0\ 63\frac{1}{2}$	
Difference per ton in favour of Marsac		$0·63
Total net difference per ton in favour of Marsac		$3·50

Recapitulation. (*Ontario Tonnage.*)

5,650 tons of ore milled in 1891, at difference of $3·50½ per ton (or saving by Marsac over Ontario, per year)	$91,057·09

The apparatus employed at the Marsac mill was designed with a view to minimise labour to the utmost. The calcination is effected in the Stetefeldt stack furnace, the calcined ore being allowed to cool slowly in heaps, the advantage of which I have already pointed out. The lixiviation vats are of 50 ton capacity, provided with sluice gates for rapid discharge of tailings, and with Körting injectors for hastening filtration. The precipitated sulphides are collected in Johnson filter presses, and the cakes of sulphide dried in a steam chamber.

Miscellaneous.

THE PROPERTIES OF THE KOLA NUT.

The tree which produces the kola nut grows only in very limited regions, but its properties are known throughout the Dark Continent, and there is scarcely any African territory where the fruit is not an object of considerable commerce. By means of it the natives can, with doses not exceeding forty grammes a day, make very difficult marches and undertake very laborious work under the tropical sun without any difficulty. The kola enables them also to take less nourishment, and to live without loss of strength or vitality. By use of the kola it is stated that the burden which could only be borne by eight Brazilian negroes can easily be carried by four African negroes. According to Dr. Gustave Le Bon, who has devoted some attention to the nut and its properties in the *Revue Scientifique*, the introduction of kola is only of recent date. From a chemical standpoint, the composition of the nut is still imperfectly known; from a physiological standpoint its effects have varied very considerably. When the grains of the kola tree first came to Europe, chemists submitted them to analysis, and as large quantities of caffeine were found, it was naturally supposed that caffeine was the active principle of the kola, and that, therefore, it was much more simple to substitute this alkaloid for it. Maintained at the French Academy of Medicine by the high authority of M. Germain See, this opinion naturally retarded for a long time, at any rate in France, the judicious use of the kola. The question of the principles to which the kola nut owes its properties has provoked numerous inquiries, and many results have been obtained by different experiments. The most important analyses are those published by Heckel. He found in the kola nut 2·35 grammes per cent. of caffeine and ·023 grammes per cent. of theobroma. The original part of the analysis of Heckel was to establish a particular body—the red colour of the kola which exists in the proportion of 1·3 per cent. in the nut, he obtained it by treating with water the alcoholic solution of the kola, but did not succeed in defining its chemical constitution. Having seen by experience that caffeine alone would not replace the kola nut, and finding in it no other substance than caffeine, theobroma, and the red portion of the nut, Heckel was led to suppose that to this red portion of the kola was due in great part the action of the nut. A chemist of Orlangen has maintained that the red of the kola nut was a glucoside, susceptible of decomposition in the presence of water into caffeine and a colouring substance. The red of the kola nut, under the influence of mastication, is transformed in a great part into caffeine when it arrives in the stomach. Heckel cites in support of his experiments upon man, investigations in the laboratory, which show that the kola increases and prolongs the intensities of the muscular contractions, while with the caffeine the stimulation is of very short duration and wears itself out very rapidly. For those who desire to make use of the kola nut the advice is given to consume it exactly as do the African negroes—that is to say by masticating slowly fragments of the fresh nuts, and to reject completely all other preparations. Fresh nuts are to be taken in preference to dried nuts, as the last are valued little by the negroes and are produced from a very inferior variety of the kola. Nothing is easier than to obtain fresh nuts, when required, for medical or other purposes, from the coasts of Africa, at a cost of two or three francs a kilogramme, and to preserve them in this condition for a long time. They have been kept for more than six months, by simply covering them with moist leaves, and by rolling them up in sugar, or some saccharine preparation, they may be kept for a much longer time than this. Fresh nuts, by reason of their characteristic appearance, cannot be adulterated, whereas, when they are dried, it is impossible to recognise by their appearance the true kola from the false. The negroes frequently substitute spurious kolas for the true ones, and the former belong to a very different family, containing no trace of alkaloids.

THE MEERSCHAUM MINES OF ANATOLIA.

Rich deposits of meerschaum are found about twenty miles to the south-east of Eski-Shéhir, an important station of the Anatolian railway. It would be difficult to determine the exact area in which the

meerschaum is to be found. Judging from the number of pits all over the place, and at considerable distances from each other, it must be extensive. The localities where most work is carried on are Sepeldji-Odjaghi and Kemikdji-Odjaghi, at a distance of three miles one from the other. The meerschaum is extracted in the same way as coal. Pits from 25 to 120 feet deep are dug, and as soon as the vein is struck horizontal galleries, sometimes of considerable length, are made, but more than two galleries are seldom to be found in one pit. The stone as extracted is called *ham-tash* (rough block) and is soft enough to be easily cut with a knife. It is white, with a yellowish tint, and is covered with a red clayey soil of about one inch thick, In this state the blocks are purchased by dealers on the spot, not by weight nor by measurement, but according to approximate quantity either by load of three sacks or per cartload, the price varying from £5 to £30 per load according to quality. These rough blocks are dried and subjected to certain preparations before being conveyed to Eski-Shéhir. Some of them are as small as a walnut, while others attain the size of a cubic foot. Those which combine regularity of surface and size are the best. The manipulation required before they are ready for exportation is long and costly. The clayey soil attached is removed and the meerschaum dried. In summer exposure for five or six days to the sun's rays suffices, but in winter a room heated to the required temperature is required, and the drying process takes eight or ten days. When well dried the blocks are well cleaned and polished; then they are sorted into about twelve classes, each class being packed with great care in separate cases and each block being wrapped in cotton wool. The dimensions of these cases vary according to the five classes they are divided into in accordance with the "Zol-wien" system which has recently been generally adopted owing to the fact the bulk of the meerschaum is sent to Vienna where it is worked and sent all over the world. Most of the finest specimens are sent direct to Paris. Certain American dealers have visited Eski-Shéhir with the object of obtaining the raw article direct instead of through Vienna, thereby saving the higher custom house duty payable on the worked meerschaum. The quantity annually exported is put down at 8,000 to 10,000 cases. The various taxes levied by the Turkish Government amount to about 37 per cent. *ad valorem*. It is maintained locally that the Eski-Shéhir meerschaum is superior to that of Sebastopol and Caffa, in the Crimea of Egrilos (Negropous), and of Corinth. At Kilshish, two miles from Konia, meerschaum is also to be found.

COFFEE PRODUCTION IN THE MONTANA OF PERU.

Peru has been known for many years as a coffee-producing country, but the coffee grown on the coast has been absorbed by domestic consumption, and Peru's appearance as an exporter of this article is of recent date, although she is now likely to be a considerable competitor with other countries. Coffee planting began, and coffee is still cultivated near the port of Pacasmayo, with success. But although the cultivation on the coast could be somewhat extended, it must always remain restricted, as there are only certain favoured localities in which the planter can hope for a good return. The acting British Consul at Callao says that the region which Peru offers to the coffee planter unsurpassed in fertility, and almost unlimited in extent, is situated on the eastern slope of the Andes, at a height of from 6,000 to 2,000 feet above sea level, among the net-work of streams and rivulets that find their way into the great affiuents of the Amazon. This region, known as the Montaña, has hitherto been shut off from the world by lack of communications, and, above all, by the difficulty of crossing the high ridge of the Cordillera that bars it from the coast. In spite of these difficulties, coffee has been cultivated both in the south, in the gold-bearing districts of Sandia and Carabaya, and in the centre of Peru in the valleys of Chauchamayo, Vitoc, and Huanuco. It is the Chauchamayo district—for most of the coffee that passes under the name of Vitoc or Huanuco comes from Chauchamayo—which is the real coffee-planting district of Peru, and it is the production of this region that has elevated Peru to the rank of a coffee-exporting country. This is due to the completion of the Central or Oroya Railway, by the Peruvian Corporation, to its present terminus at Oroya, giving railway carriage over the crest of the Cordillera, and also to the opening up of the Perené and adjacent valleys which form its prolongation. Oroya is about 60 miles from Chauchamayo valley, and there is a fair road all the way, passing through the town of Tarma, the capital of a department with about 7,000 inhabitants. The Chauchamayo Valley, itself about 10 miles long, is now in the hands of private owners, but the rich and far more extensive valleys beyond it of the Perené, Paucartambo, and Rio Colorado, have now been linked on to La Merced, the last town in Chanchamayo by the extension of the Tarma-Chauchamayo road through a short but difficult defile. The output of coffee for the whole region was about 1,500 tons in 1893, but extensive planting has lately taken place and production will shortly, it is said, be trebled. It is considered that coffee can be grown at the expense of 5 Peruvian soles (sole = 2s.) per quintal, or 100 lbs., the yield of a tree after the third year being about 3 lbs. The average cost of clearing may be taken at 65 soles (£6 10s.) a hectare, or £2 12s. an acre. The number of plants that can be planted with advantage on a hectare (2·47 acres) is about 1,700 to 1,800, or, say, 700 to the acre, although a larger number is often put into the ground. Young plants can be obtained for 10s. per 1,000.

Journal of the Society of Arts.

No. 2,231. Vol. XLIII.

FRIDAY, AUGUST 23, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

RECENT AMERICAN METHODS AND APPLIANCES EMPLOYED IN THE METALLURGY OF COPPER, LEAD, GOLD, AND SILVER.

By James Douglas.

Lecture III.—Delivered May 5th, 1895.

Furnace Treatment of Copper.

Immediately after the close of the Civil War the export of argentiferous lead to this market drew attention and attracted British capital to the Rocky Mountain regions of the United States. It was not long, however, before local smelters deflected the ore not only from British, but from Atlantic Coast works. The refining of the lead, and the separation of the precious metals, speedily followed the reduction of the ore in the Western establishments. The same sequence of events has occurred in the metallurgy of copper.

The mines of Arizona, at surface, yielded only oxidised ore, whose grade was so low, and whose metallurgy was so simple, that they were from the first treated on the spot; but from California, as far back as 1864, notable quantities of copper ore found their way to England; and Montana, until quite recently, has shipped to your smelters, first ore, and then matte, in such abundance, as to have constituted one of their main sources of supply. Now, comparatively little matte leaves the United States, and the separation of the precious metals from copper is there being extensively effected.

It is a cardinal principle of American industrial life, that what can be done abroad can be done at home, and that if there is any profit in the doing thereof, that profit may as well accrue to the producer, or, at any rate, to his countryman. As a consequence, crude material of all kinds will be exported in diminishing quantities from the United States, but will be manufactured at home into articles of ultimate utility, and in those forms compete in the markets of the world with the produce of Europe's workshop. The per-centage of cost chargeable to labour is higher in winning the crude material of any industry, than in converting it into finished forms. Hand labour virtually ceases, for instance, when the farmer turns over his wheat to the miller of Minneapolis; so in our profession it is in the mining of iron and copper ores, and of the coal for their reduction, that labour plays a more conspicuous figure than in directing the automatic machinery with which all the best furnace plants and rolling mills are now equipped. Further, the stimulus to mechanical invention and application, which high labour cost impressed upon American metallurgy, will not exhaust itself, no matter how rapidly labour cost may decline or approximate the European standard. If, therefore, heretofore, with the great disparity in wages which has prevailed, competition in certain branches has been possible, the field henceforth of successful competition will undoubtedly be enlarged, and the struggle in the arena of the world's market become keener and keener.

Prior to the imposition of the heavy tariff, necessitated by the war, copper entered the United States free, and was an article of commercial exchange, especially with Chili and Cuba. At that time the annual production of the United States was only about 7,500 tons, of which the Lake region contributed 98 per cent. The balance came from sulphuretted ores of the Appalachian range between Vermont and Georgia. The mineral (concentrated metallic copper) of the Michigan mines was smelted at Hancock on Portage Lake, within the mineral belt; at Detroit; and at Pittsburg. The sulphuretted ores of the Ducktown mines, Tennessee, were reduced and refined on the spot, but those of the small mines of Virginia, North Carolina, and Maryland were shipped chiefly to Baltimore, and there smelted with foreign ores. At that time there were also small copper smelting works at Perth Amboy, on the New Jersey coast; at New Haven, Connecticut; and near Boston; but their operations were conducted on a very small scale, and when the foreign supplies were cut off by the high tariff, all were either closed or confined their operations to rolling copper, except the Baltimore works, which, amidst many vicissitudes, have survived. From 1860 to 1880 production and consumption in the United States were nearly balanced; but from that date, pro-

duction has gained so rapidly on consumption that the excess available for export may be set down at from 60,000 to 70,000 tons annually. The present production of copper in the United States is, in round numbers, 160,000 long tons, and the home consumption 100,000 tons. The balance is available for exports.

COPPER WORKS ON THE ATLANTIC COAST.

This large amount of copper is made and refined partly in works on the Atlantic coast, partly in the neighbourhood of the mine. Of the Atlantic coast works, the Baltimore Copper Works, which are by far the largest, confine their operations to making bluestone, and to reducing matte to copper, and refining the copper electrolytically. This is done in two large electrolytic plants, whose capacity is 52,000,000 lbs. annually, and which are supplied with material almost exclusively by the Anaconda Company. Baltimore has always followed the old English system of smelting, and been manned by Welsh smelters.

The Orford Works were built in 1881, at Burgen Point, New Jersey, primarily to smelt the cinder from pyrites, mined by the same company in Canada, and burnt by the acid makers in the neighbourhood of New York; but their operations immediately assumed a wider range, and they became competitors for furnace material from Butte and elsewhere. They use large brick matting furnaces, but bring up their regulus to blister in reverberatories. They cast their argentiferous and auriferous material into anodes, which are electrolysed at the Balbach Works in Newark, New Jersey. But, in addition, they make a brand of casting copper, which is submitted to the same tests and ranks with the best select of English smelters. The Orford Works, from the first opening of the Sudbury mines, made the treatment of nickeliferous copper mattes a subject of experimental investigation, and they are to day the largest American manufacturers and shippers of nickel and nickel oxide. The refining capacity of the works is about 3,000,000 lbs. of copper monthly, but, as they have no independent and assured Western source of supply, their output is variable.

Near the Orford Works are those of the New Jersey Extraction Company. They were built about the same period, under the superintendence of the well known metallurgist, Mr. Thomas Gibbs, by parties interested in the sale of Rio Tinto pyrites, for the purpose of leaching the burnt cinder by the Longmaid-Henderson process. The supply of the material being inadequate, the works were soon converted into smelting works, but their output has been generally below their capacity. These three large works have been substantially the only general smelting establishment capable of handling both ores and mattes.

There have, however, of late years been constructed several other copper works, some connected with chemical establishments, some independent, and all now provided with electrolytic refining departments, whose aggregate production is very considerable. They are the following:—

The Nicholls copper Plant attached to the Laurel Hill Chemical Works, in the suburbs of Brooklyn, was originally designed to matte the cupriferous residues from the pyrites of their own mines, burnt in their own works. The mattes were for many years exported, but recently Bessemer converters and an electrolytic plant have been added, and the firm now bids for Western furnace material. Their capacity is about 2,000,000 lbs. a month.

Still another Eastern copper plant has its origin as an adjunct to acid works, that of the Pennsylvania Salt Works at Natrona. The Company have for many years burnt Rio Tinto pyrites, and extracted the copper therefrom by the Longmaid-Henderson method. They have now extended their operations to purchased ores, and erected an electrolytic plant of about 1,500,000 lbs. monthly capacity. The Parrot Company of Butte have for many years refined their Bessemer pigs, and separated the precious metals electrolytically, at their works at Bridgeport, Connecticut, which works have a capacity of over 1,500,000 lbs. monthly, and the Messrs. Lewisohn have electrolytic works both in Rhode Island and Ansonia, Connecticut, whose joint capacity is about 2,000,000 lbs. monthly. Recently two new establishments on the east coast have been erected to refine copper electrolytically, which it is expected will be provided by their own mines. One is at Fairfield, Connecticut, whose mines are in Nevada, the other is at Perth Amboy, where will be accumulated for treatment the copper made by the Messrs. Guggenheim, partly in Mexico, and partly in Colorado.

While the East Coast works have been enlarging their refining capacity, the mines, which furnished material to them, have been erecting independent refineries in the West. Hereafter, therefore, more electrolytic and less casting

copper will be produced; less and less unrefined copper will be exported, and, now that the duty on imported copper has been removed, the Eastern refineries will endeavour to replace the Western material, of which they are sure to be deprived through the establishment of Western works, by the importation of foreign ores and furnace material.

The metallurgical improvements which have been most influential in enabling the West to make itself independent of the Eastern refineries have been the pneumatic method of concentrating matte and the electrolytic method of separating the precious metals from metallic copper. These two operations, fulfilling the required conditions of Western usage, that machinery shall to the utmost displace hand labour, have completed the series of mechanico-metallurgical methods and appliances, through which alone it has been possible to utilise profitably some of the complex and by no means high-grade copper ores of the Rocky Mountains.

Smelting of Lake Mineral.

When we review the Western works, we find that the simplest ores of copper, and those, therefore, from which that metal is recovered by the simplest means, are the native copper ores of Lake Superior. In a previous lecture, the concentrating mills, by which the ore is enriched to mineral of over 70 per cent., have been described. The smelting and refining of these concentrates is effected at one operation in refining furnaces, which do not differ in any material respect from the recognised form. In days gone by, when Mass copper was one of the products of the Lake mines, refineries with removable roofs were built, so that masses of 10-ton weight could be deposited by cranes on the bed of the open furnace, and the roof then replaced and luted down.

Smelting of Oxidised Ores in Arizona.

Almost as simple a metallurgical operation has been the production of black copper from the oxidised ores of Arizona. Although other sections of the United States have yielded small quantities of carbonate ore, in Arizona alone have been exposed as yet large bodies of decomposed sulphides converted into oxides of copper and iron. All the large mines have, however, struck sulphides, either completely or partially unaltered, and therefore have already introduced modifications in their mode of treatment, or are considering how best to overcome the complications which the presence of sulphides inevitably involves. Heretofore the oxidised ores, where the same mine, as is the case of the Copper Queen, supplied both basic and acid ores, have been fed with coke alone into water-jacketted furnaces, and from the furnace has been tapped copper, combined with more or less iron and sulphur, and a slag carrying from $1\frac{1}{2}$ to $2\frac{1}{2}$ per cent. copper. In other districts, the ore being too acid, more or less limestone or iron has to be added to the charge.

The furnaces invariably used in this district are water-jacketted cupolas, either circular or oval, tapering slightly from feed door to crucible. The short diameter at the tuyeres, whether of round or oval shells, seldom exceeds 36 inches through for open charges furnaces of 42 inches, or even 60 inches, are built. The long diameter of the large Queen furnace is 72 inches, but that of the largest oval-shaped furnaces at the Arizona Copper Company and the Detroit Copper Company Works at Clifton are 120 inches. Owing to the liability of the metallic copper to chill, outer wells cannot be used, and therefore the copper is tapped directly from the crucible, through a tap hole, generally 18 inches below the tuyeres. It inevitably follows that the slags, drawn from a bath through which particles of 96 per cent. copper are descending, must be rich. The operation was wasteful, but none other under the conditions has in the past been more profitable. The large furnace of the Detroit Copper Company has a small fore-hearth, the water-jacketted shell of the furnace serving as a tymp. This allows the copper in the slag a slightly better opportunity of settling, but the benefit is slight. The furnaces are everywhere hand fed, with charges varying in different establishments from 300 pounds to 500 pounds.

The coke consumption varies with the character of the ore, and the character of the coke, from one of coke to six of ore to one of coke to eight of ore. The per-centage of copper in the charge is also determined in the different districts by the cost of treatment. It is possible, by rejecting ores of lower grade, to raise a furnace mixture to almost any given standard which it will pay to smelt. For instance, at the Copper Queen Mine, which is connected by a line of standard gauge with the railway system of the south-west, the management is satisfied if a yield of 7 per cent. of copper is obtained from wet ore fed into the furnace; whereas, heretofore, at the Grobe furnaces, where coke, hauled 150 miles from the nearest railway station, has cost over 40

dollars per ton, ore had to be selected so as to give a furnace yield of about 12 per cent. The copper contents of the copper bars is also variable. Tapped directly from the cupola they cannot be made of the same uniform per-centage as Chili bars, which are brought up to a given standard in the reverbatory furnace. The per-centage of the bars is influenced by the character of the charge, being higher where lime is the base and lower where iron predominates. Those made from the Queen furnaces of late years, since the charge has become more and more ferruginous, have been lower than those made at Clifton and Globe. But the bars now made at the Queen furnaces at Bisbee, where the pneumatic method has recently been introduced, run higher, on an average, than any bars made directly from carbonate ores.

The water-jacketted furnace is an actual necessity to the Western smelter owing to the heavy cost of refractory building material. When the owners of the Longfellow Mine at Clifton commenced smelting in 1873, the nearest railway station was 700 miles distance.

The first furnaces used there were small Mexican *adobe* cupolas, the capacity of which is little over one ton daily, the blast being derived from large bellows worked by hand. Reverberatory furnaces were next tried, but the ores being basic, and firebricks worth a dollar apiece, the cupola was again resorted to. This time it was supplied with an iron water-back and water tuyeres. The water-back once burning out, an attempt was made to cast one in copper as a substitute, but the casting turned out to be a mere plate with a hole in it. For lack of better, this was built into the furnace, and was found to stand so well that the cupolas, within the area of fusion, were constructed entirely of copper slabs, cooled at first by a spray of water, afterwards by the air alone. Such copper-plate furnaces lasted in good order for about sixty days when charcoal was used, but the intense heat produced by coke twisted the plates out of shape so rapidly that they were replaced by copper water-jackets—clumsy, deep copper troughs, open at the top, which were cast in close moulds from the coarse alloy of copper and iron made by the furnace.

In like manner, the iron-jacketted furnace has been the outgrow of the water tuyere and water back, and cannot be assigned to the inventive genius of any one metallurgist. The 36 inch furnaces used from the first at the Copper Queen Works at Bisbee were designed by Mr. Lewis Williams, still the superintendent of the works, and were built by the Pacific Iron Works, San Francisco; but other Western and Eastern machine shops soon competed for the trade, and took out patents for immaterial modifications, advertising their trifling changes in construction as important innovations, and publishing the record of their furnaces when running on some exceptionally fusible ore, as if the quantity smelted were due to the peculiarities of the furnace, when in reality it depended on the character of the charge. No patent covers the use of an inner and outer metallic shell, between which water circulates in quantity sufficient to cool the inner shell in contact with the smelting charge. Every smelter, therefore, may and does design a furnace of the proportion and shape he considers best adapted to the ore he has to treat, while any boiler-maker may build it without fear of infringing any rights.

The quantity of ore a jacket of given size will smelt depends upon the fusibility of the charge, the strength of the blast, and the supply of water. The 3-foot round jacket is usually designated a 30-ton furnace. Under exceptionally disadvantageous circumstances a furnace of that size will smelt only 30 tons, but with fair ore and good management it smelts from 45 tons to 60 tons per day. The large furnace at the Copper Queen (36 in. × 72 in.) under 12 oz. blast, smelts as high as 160 tons daily, the ore being exceedingly fusible, whereas the Arizona Copper Company's furnace of larger size, on less fusible ore, puts through only 100 tons daily. No statistics are available of the relative capacity of brick and jacketted furnaces, nor is it possible, otherwise than by actual experiment, under exactly similar conditions, to determine whether more heat is lost by radiation from the brick furnace than by convection in heating the water of a jacket As bearing, however, upon this point a modification of the jacketted furnace introduced and applied by Messrs. Walker and Murphy at Globe, is interesting. They force the blast around the hot crucible, which is simply brick-lined and not water-jacketted, with the following results, the temperature having been taken for about a week in summer at all hours of the day:—Blast entering the air jacket, 99° F.; blast leaving, 154° F.; difference, 55° F.

A twenty days' run for comparison was made between two furnaces of the same style and size fed with the same ore and coke, all conditions as nearly equal as it was possible to make them, which gave the following results,

Furnace No. 1 was without the wind jacket, and No. 2 with it:—

	1		2
Ore smelted	2,233,600 lbs.	..	2,325,000 lbs.
Per-centage of coke. to ore.........	17·67 per cent.	..	16·84 per cent.
Per-centage of coke. to burden	13·60 per cent.	..	13·00 per cent.
Number of charges smelted	3,756	..	3,875

The difference therefore seems to be in favour of No. 2 to the extent of 91,400 lbs. more ore smelted, and 19,297 lbs. of coke saved, and an increased average burden of 4 per cent,

If the heat radiated from the crucible alone was effective in raising to such an extent the temperature of so large a volume of air, the loss of heat by radiation must be enormous in the ordinary brick furnace, and it makes no difference whether that be carried away by water or dissipated in the air. A real improvement would be devising an air-jacketted furnace which would not buckle, and in which the blast could be raised to a much higher degree than is done by simply air-jacketting the crucible, as in the above modification.

The space between the inner and outer shells of the water jacket is generally wider at bottom than top, to facilitate the removal of sediment, and is necessarily wider where the water is very calcareous than where it is pure. The water jacket seldom extends over the crucible. When the furnace is first blown in, the iron shell is exposed to the full influence of the heat, and more water is required than after the furnace is run a few hours. Soon a coating of slag protects the iron and a rim forms below the feed door, which slightly deflects the gases from the periphery of the furnace. The issuing water may be almost boiling, but where the water is very calcareous and abundant, it is preferable to allow it to flow cool through the jacket, so as to diminish as much as possible the separation of lime. By attaching to the top of the jacket a regular boiler, separated from the influence of the furnace heat, the water may be allowed to boil in the jackets and the cold water be admitted by a valve from an elevated source only as fast as a water-gauge in the boiler above the jackets shows that it is being evaporated as steam. Mr. W. H. Pearce has designed a furnace at Baltimore which is run very successfully on this system.

Till Bessemerising was introduced into Arizona—and that was very recently—the peculiarity of Arizona smelting has been the simplicity and smallness of the plant needed to make such a considerable quantity of copper. No calciners have been employed to prepare the ore for the smelting furnaces, which have consisted of simple jacketted cupolas, distributed as follows:—At the Queen's smelter, 4; at the Old Dominion smelter, 3; at the Arizona Copper Company's smelter at Clifton, 5; at the Detroit Copper Company's smelter at Morenci, near Clifton, 3; at the United Verdi smelter, 3; total, 18 cupolas, and these never all in blast at the same time.

At all the Southern Arizona furnaces, more or less, matte, derived from imperfectly oxidised ores, has for years been tapped with the black copper, roasted in kilns or heaps, and returned to the black copper furnace. At the mines of the United Verde Company, at Jerome, in Central Arizona, whose ore deposits are in compact slates, the carbonate ores are very superficial, and the deeper ores have been exclusively rich sulphides. They have, therefore, been heap-roasted, and smelted in water-jacketted cupolas, with the production chiefly of matte. Reverberatories have been used there, to a limited extent, for the matting of ores carrying the precious metal. Now, however, the non-argentiferous mattes are being converted into copper in Bessemer convertors, of which three, with their supplementary shells, have been erected. They are of the ordinary upright type.

At the Copper Queen Mines the matte had become so abundant, that Bessemerising has been resorted to exclusively for the treatment of both the oxidised ores and of the large bodies of sulphides which have been met with during the extraction of the carbonates. Although in parts of the mine carbonates are being mined on the 400 feet level, where that level is actually 1,100 feet vertically below the apex of the hill, in other parts the sulphides have been so protected from decay that they occur unaltered on the second level. As there are, therefore, available large quantities of both classes of ore, matte is made by mixing oxides and sulphides in the jacketted furnaces, and thus dispensing with the cost of roasting. These mattes are concentrated in trough converters, which will be described more fully when treating of the Bessemerising of copper mattes in the United States.

The only large establishment in the United States using cupolas which has not adopted the water-jacketted type is that of the Orford Company. They smelt in large cupolas built of brick, between the layers of which, how-

ever, are interposed horizontal iron pipes through which water circulates.

Furnace Wells.

When used for matting, a well is almost invariably attached to the cupolas. Contrary to the usual practice in Europe, these wells are extensions of the crucible, and not detached. The simplest form is a box of iron plates bolted together. A large hole is cast in the rear plate, a spout is attached to the top of the front plate, and a long slot is cast in one of the side plates. The top of the hole behind is three or four inches below the spout. When, therefore, the well is luted against the corresponding aperture in the furnace and the well is filled, the molten material stands slightly more than three or four inches above the furnace aperture, and no blast can issue. Mr. Herreshoff, the manager of Nicholl's Laurel Hill Works, obviates the difficulty of handling a very corrosive furnace mixture by interposing a water-jacketted ring between the furnace and the well, and water-jacketting the well. He builds his wells circular and shallow. Herreshoff also now builds his furnaces in sections, and makes the outer shell and the flanges of each section of cast iron, wrapping, as it were, a sheet of steel over the cast iron flange for the inner shell. The blast pipes are cast as a part of the outer shell. This style of construction has many advantages for large, oval, or rectangular furnaces. The most novel appliance for automatic discharge was devised by the Orford Company. It is a well divided by a longitudinal partition into two unequal compartments, the partition being provided with a vertical slot extending some inches upwards from the bottom. Into the large compartment slag and matte flow from the furnace, and from it slag flows continuously, while the matte only runs through the slot in the bottom of the partition, and flows through a spout about two inches below the level of the slag spout of the first compartment. When the flow of matte is rapid, this automatic contrivance works to admiration.

Copper Smelting in Montana.

Though Arizona was conspicuous as a copper producer before Montana, the latter was no sooner provided with railroad facilities than she rapidly outstripped her Southern rival; then surpassed in production the Lake region, and may now claim to export more copper, not only than any one district of the United States, but than of any country in the world, except the United States.

We may, in round numbers, put the world's total production at 303,000 tons, equal to 678,020,000 lbs. Of this, the United States produces 329,350,000 lbs., equal to 48·5 per cent. of the whole; while Montana alone must be credited with 155,200,000 lbs., being 47·1 per cent. of the United States and 22·8 per cent. of the world's production.

All, except a trifling share of this large volume, comes from the mines of Butte, but the great bulk of it is smelted elsewhere in the State of Montana. The ore from the Anaconda group of mines is treated at Anaconda, and that from the Boston and Montana at the great falls of the Missouri. At both these points water for concentration is abundant, while at the great falls of the Missouri, that river, which almost at its source has a larger volume than where it joins the Mississippi at St. Louis, affords almost unlimited water power. The Butte and Boston Company concentrate their ore into matte at Butte, but the further concentration, refining and separation of the precious metals is done by the Boston and Montana Company at the Great Falls. The next largest works in the immediate vicinity of Butte, those of the Parrot Company, are about to be moved to a more convenient locality, where water will be more abundant. A new producer, whose works have grown out of an ore purchasing company, and treat ores extracted from its own mines, and partly purchased ore. These works, known as the Heinze's Works, are near the Company's mines at Butte. They have within the two last years attained prominence, having gradually increased its capacity to 18,000,000 lbs. a year. The copper leaves their works as Bessemer bars.

Two other works near Butte aim at making copper an almost secondary product to the precious metal, viz., the Colorado Smelting Company's Works, known as the Williams Smelter and the Butte Reduction Works, known as the Clarke Smelter.

The extent of the metallurgical operations in Montana, devoted to copper alone, and dependent on the Butte mines, will be appreciated by the fact that there are available for their reduction about 200 mechanical calciners, 60 reverberatory furnaces, exclusive of refineries, 10 large cupolas, 20 sets of Bessemer converters, and 2 large electrolytic works.

At all these works the furnaces are fed chiefly with concentrates, and reverberatory furnaces are preferred to cupolas. But cupolas are gaining ground at several of the works, and do most of the matting at the Butte and Boston, the Parrot, and the Ore

'urchasing Company's smelters. Mechanical alciners may be said to be exclusively used, nd these are at the largest and newest works ituated above the level of the smelting furaces, which are fed from hoppers through the oof. The whole charge being dropped at nce from the Brückner cylinder hot, and ransferred rapidly to the reverberatory, inreases the capacity of the latter to such an xtent that 50 tons per diem may be taken as fair average of their service. The slag is ranulated and removed by water at both naconda and Great Falls. The reverberaories of the Anaconda Company are large, ut of the ordinary type, and heated by solid uel. Those of the Boston and Montana Company are designed after the model of the ilting open hearth steel furnaces of the Pennylvania Steel Company, and are heated by roducer gas. The furnaces are built in a teel shell, to which are rivetted sections of ings, which rest on friction rollers. They re rotated by hydraulic machinery. It was eared that the jar, in moving the furnace, vould diminish the life of the roof, but this as not been found to be the case. The Bessemer plant of the Anaconda Works being n a separate building from the reverberaories, the matte is allowed to cool, and is e-melted in cupolas above the converters; ut in the Boston and Montana works at Great Falls, the matte is poured from the reverberaories into large ladles, which transfer it lirectly to the converter.

At the Great Falls Works a row of these ilting reverberatories lines one side of a large it, on the opposite side of which is a row of four large converters. The intervening space s occupied by a powerful electric travelling crane, which handles in ladles the matte between the reverberatories, and the converters, and the converter slag, pouring it back into the reverberatories. The same crane removes the 15-ton converters from the stands to the relining room, and replaces them with relined shells. The reverberatories are tilted when the charge is melted, and the bulk of the slag is poured into a stream of running water, large and swift enough to remove it. The charge is cleared of residual slag by skimming. The matte is then poured into the ladle. First-class lump ore is smelted in water-jacketted cupolas, furnished with large wells, in which the matte is accumulated before being transferred directly to the converters. A comparison of the cost of smelting s slightly in favour of the cupola, and is likely to become more distinctly so, as the manufacture of Montana coke increases and improves.

Bessemer Smelting.

The Bessemer plants of the Montana Works constitute their most distinctive feature, and are deserving of special study. The credit, not only of introducing M. Manhès' modification of the steel converter to the exigencies of copper smelting, but of applying the process on a large scale, is due to Mr. Franklin Farrel, who, in 1882-3, erected two converters at the Parrot Works, in Butte. At first the operation of making bars consisted of two steps—blowing a 40 to 50 per cent. matte to a grade intermediate between blue and white metal, then casting, re-melting, and blowing this up to metallic copper. The difficulty of the process has always been met, whether by Hollway, or when the convertor was, very early in its history, used in Russia, as soon as metallic copper began to form and chill in the tuyeres. This obstacle M. Manhès combatted, by elevating the tuyeres, and inserting the blast through the side instead of the bottom of the converter. Ultimate success was achieved by so devising the tuyere boxes and tuyeres, that they could be readily reached, when necessary, and rapidly punched. Now the charge of matte is everywhere blown up to metal at one operation. The practice of the four Butte establisments, which convert, does not differ in essential particulars. All use upright converters, which remain stationary during the blow. The largest are those in the Boston and Montana works at Great Falls, which are an exact reproduction of the 15-ton steel converter, except that the tuyeres are elevated 18 inches above the bottom of the shell, so as to be on or above the level of the fresh lining. Three shells are the complement for each stand, one in position and two in the relining room. Each of these large converters in position can make about 60,000 lbs. of copper from 55 per cent. matte per diem in 10 blows, or an average of 6,000 lbs. per blow. Owing to the great depth of the charge the gauge at the converter at the Boston and Montana works registers generally 15 lbs. There the blast is produced by large vertical blowing engines of the ordinary iron blast furnace type, moved by water power, and erected at the power-house half a mile distant from the converter-house. The lining of the body of the converter consists of nine-tenths crushed quartz, and one-tenth clay, and lasts on an average seven blows when running on matte of 55 to 60 per cent.

The largest plant, however, is that of Anaconda, where eight converters in place, capable of holding five tons of matte in each, are fed from re-melting furnaces, erected on a platform above and to the rear of the converters. An electric travelling crane handles the converters between the converter stands and the relining-room. At the Parrot and Heinze Works the converters are transported on carriages.

The quartz and clay are ground and mixed in Chili mills and either pounded into the converter shell around a templet or made into balls and built up and moulded by hand. The practice is to use the more siliceous lining for the body of the converter, and a more argillaceous for the roof.

The actual cost of Bessemerising, the companies who practise it are reticent in revealing. Three items cover the main expense, first, the power to produce the blast, second the material for and the labour of replacing the lining, third the loss.

First. Where water-power is available, as at the Great Falls, the first item consist of maintenance of blowing plant only; where, however, fuel has to be consumed, the shallow trough-shaped type of converter, which is used at the Copper Queen Works, Arizona, is operated with less pressure, and therefore with less consumption of fuel for the production of blast, than the deep converter.

Second. The cost of relining is the heaviest item. As yet no one has devised a mode, which is altogether satisfactory, of adding silica to the charge otherwise than in the lining; and, therefore, the best Butte practice, and, in fact, the almost uniform practice, is to treat a matte with not less than 55 per cent. of copper, whose iron contents is about 25 per cent., and to reline, on an average, every seventh charge, patching the converter at weak points in the interval. The slag produced at the Butte works, running on 55 per cent. matte, is of the same general composition as that made at the Copper Queen, running on a matte of about 10 per cent. lower grade. The following is an analysis of the principal constituents of Copper Queen converter slag of both first and second pourings made in concentrating to white metal:—

ANALYSIS OF CONVERTER SLAG.

First Pouring.		Second Pouring.	
Fe	43·5	Fe	45·1
Cu	1·4	Cu	1·4
Ai	1·4	Ai	1·4
Si	36·1	Si	34·3
S	·6	S	·4

It is doubtless possible to make a mor basic slag by using a very refractory clay, an more of it. By this means the silica is pro tected from the iron oxide, which, in that cas combines with it to form a slag high in iron But such experiments as I have made with very argillaceous lining led me to think that retarded the celerity of the operation. Th most economical method would be that c adding silica in a valuable siliceous ore to th charge. In practice it has been found tha when thrown in through the mouth of the con verter, the silica simply floats on the top; blown in through the tuyeres, it more or les clogs them; and each particle of cold silic seems to surround itself with a shell of chille material, which apparently arrests furthe action till the particle has floated up out c reach of the matte. When a method is foun of adding silica, either solid or as a ver siliceous slag, to the charge, or of using basic lining, it will be economical to treat much lower grade matte than is the presen practice in American works. In Leghorn Italy, where lining material and labour ar cheap, a matte of 33 per cent. copper i advantageously tapped direct from the cupol well, and blown up at once to metal; but i Butte, the high cost of ground silica and clay and of the labour of packing it into the con verter, necessitates the treatment of a muc higher grade of matte. Experiments wer made in Butte with a basic lining, but wer abandoned, it is understood, owing to the im possibility of maintaining the temperature c the charge. But this difficulty has not bese the very interesting operations by Messrs. A and W. Raht, at the Philadelphia Smeltin Works, at Pueblo, Colorado. They have buil a barrel converter with constricted inlet an outlet at opposite ends. It closely resemble in appearance a small Brückner cylinder. A fireplace at the inlet supplies heat to melt th matte charge of about 1½ cwt. The outl leads to the stack. The converter is line with magnesia brick, manufactured for th basic steel converter. When the charge i melted, a blast of 5 lbs. pressure is turned on and the 30 per cent. matte is blown up t white metal in a shorter time than the sam concentration is effected on an acid lining The tapping is done through a tap hole in th centre of the barrel. The matte is fed, an any patching is done through a door in th base of the stack, opposite the outlet of th converter. The lining had stood, when visited the works, according to the statemen

f the Messrs. Raht, without material repair or weeks. Whether or not the success of the peration depends on the maintenance of heat rom the fireplace during the blow, will be determined when the converter is detached from he fireplace and fed with melted matte from a eparate furnace. A sample of the slag gives he following compositions :—

	Per cent.
Silica	11·6
Iron	54·6*
Magnesia	0·04
Lime	2·4
Manganese	trace
Alumina	10·2
Copper	1·4
Sulphur	2·1

It is difficult to trace the source of the silica, which was not intentionally added to the charge. The blow is stopped when white metal has been reached, because the Messrs. Raht have satisfied themselves that up to that point the loss of silver is light, above that point heavy. They, therefore, continue the concentration to blister in an open furnace, but accelerate the operation by blowing air, under considerable pressure, through two iron tuyeres, one on each side the fireplace, upon the surface of the metal, which shortens the operation without occasioning the loss of silver. The possibility is thus established of making an exceedingly basic slag poor in copper. If it should be found that to do so so extraneous heat is needed, this can be supplied to converters of the same shape as those of the Philadelphia works, or to tilting reverberatories, like those at the Boston and Montana Company's Works. In these the charge of matte may be melted, as well as concentrated to metal. The melting of matte in an upright converter, without the aid of a fireplace, is said to be practised at the Fairfield Works, Connecticut, by blowing into the converter charged with coke and matte.

Vautin, in a discussion of Collin's paper on copper, read before the Institution of Mining and Metallurgy, in London, states that he used a water-jacketted converter in Australia, and suggests carbon blocks as a lining. Apart from the danger of a jacketted converter, is the difficulty of feeding the charge with silica. The objection to carbon blocks would seem to be the tendency to reduce iron during the second blow.

Third. As to the losses, but little definite information can be obtained, nor is it very easy, in large works, to determine them accurately, except over long periods of time. That there is an unaccountable loss of both copper and silver is generally suspected; a loss larger than is made in the open furnace or the cupola. Stallman, who treated rich argentiferous matte at Durango, Colorado, came to the conclusion that the loss of silver rises with the pressure of the blast. The Messrs. Raht, of Pueblo, find that the loss is insignificant, until the metal begins to form in the converter. All are agreed that the per-centage of loss of silver is greater than that of copper, especially in the presence of lead. The only works which have supplied me with data as to losses—and as these losses include loss in transportation, and in the concentration of a low matte to a Bessemerising grade, they are not conclusive—account the loss of copper at 3, and of silver at 5 per cent.

The only trough converters in the United States are at the Copper Queen Works, in Arizona. They were adopted because it seemed unnecessary to continue blowing into a bath of metallic copper once it commenced to form, which is unavoidable in the rigid, upright converter. In the trough converter, with tuyeres on one of the long sides only, the converter can be tilted as metal forms, and the blast made to impinge only on the residual unreduced matte. It has been found in practice that converters of this shape, of the same capacity as 5-ton upright converters, can be operated as speedily with a blast of from 5 to 7 lbs. pressure; that the blow is no longer; the number of charges per diem put through is as many, and the facility which the construction offers for patching is much greater. At the Copper Queen Works the converters are raised off their standards and moved on cars designed by Messrs. Fraser and Chalmers, the raising and lowering of the lode being effected by hydraulic machinery. The operation is effected nearly as rapidly as by the electric crane. At these works running on a matte of 45 per cent., the converter, whose outside dimensions are 96 in. × 50 in., and 48 in. deep, will blow 40 tons of matte to 16 tons of 99 per cent. copper per diem. The pourings, however, vary very much—from 10 bars when the lining is new, to as much as 29 bars (containing nearly 4 tons of metal) before re-lining. These are the largest converters of this type yet built, and the fears entertained that the distance of the tuyeres from the opposite dead wall of the converter would be prejudicial, have not been realised; while the very low blast required to

* Equal to 70·2 per cent. if it be as protoxide.

handle charges of such size, represents a notable operating saving over the cost of blast in the rigid high converters.

Pyritic Smelting in Colorado.

The only other State whose copper metallurgy presents features worthy of note is Colorado. The possession of coal in the Foot Hills of the Eastern range of the Rocky Mountains, which, though cretaceous, cokes when the coal measures are overlaid by traps, has made of Denver and Pueblo great smelting centres devoted chiefly to the treatment of lead and its associated precious metals. But before the large lead works of to-day had come into existence, Professor Hill, of Harvard, since then a United States Senator, had established the Boston and Colorado Company's works at Black Hawk, in Gilpin County, for matting the heavy sulphides which formed the selvages of the gold ledges of that district, and the concentrates collected in its gold mills. At first the matte was shipped to England, but since 1873, when Mr. Richard Pearce instituted the separation of the precious metals by the Ziervogel method with certain modifications of his own, the matte has been handled in the works. These have grown in size and importance and have been transferred to Argo, near Denver, where the company could use the lines of competing railroads to draw supplies from other western points, especially Montana. Pearce has not only modified the extraction method, but has made wide departures from precedent in his smelting department. I have already described the Turret Roasting Furnace, with which he replaced the Brown O'Hara's in his own works. He also uses what I suppose can claim without contradiction to be the largest reverberatories for matting ore and for concentrating matte ever built. For the following Table and the description of his last large furnace and its performance I am indebted to him :—

"Concerning the Britannia reverberatory smelting furnace, I send you a blue print showing the increase in size of furnaces built at these works since the year 1878, together with a Table which I think needs no comment except as regards the hot ore. In the latter part of last year we adopted a system for conveying the hot calcined ore direct from the 'Turrets' to the smelting furnaces, and this change has been followed by a considerable increase in their capacity. The charges consist of about 50 per cent. of this hot calcined ore, the remainder being barytic and siliceous ore, cold as before. I have put in 50 tons per day as the average capacity of Britannia on hot ore. During the month of February she averaged 52·5 tons per day."

"This furnace is skimmed by four men throug two skimming doors at each side. The front door i not used for this purpose at all, and only occasion ally for levelling the charge. She taps, on an aver age, about every six days the 300 tons of ore smelted yielding about 25 tons of matte of 35 per cent copper, making the degree of concentration abou twelve into one."

Pearce's Table of Reverberatory Furnace Growth.

Year.	Area of Hearth.	Area of Fire Box.	Area of Fire Box.	Ratio of Hearth to Fire Box.	Tons Cold Ore Smelted in 24 Hours.	Tons Hot Ore Smelted in 24 Hours.	Tons of Coal Consumed in 24 Hours
	ft. in. ft. in.	sq.ft.	sq. ft.				
1878...	15 0 × 9 8	108	22·55	4,800 : 1	12	—	5
1882	17 10 × 10 4	143	22·50	6,351 : 1	17	—	7
1887...	21 2 × 12 8	202	24·75	8,161 : 1	24	—	9
1891...	24 4 × 14 2	262	28·50	9,192 : 1	28	—	10
1893...	30 0 × 16 0	390	32·50	12,000 : 1	35	43	13
1894...	35 0 × 16 0	456	32·50	14,030 : 1	—	50	13·5

The quantity smelted by the Britannia is not as large as that claimed for furnaces of smaller dimensions in Montana, but there the whole charge is thrown hot into the furnace, and is of much more fusible character. I shall refer to the separating department of the Argo Works in my next lecture.

There are no large mines in Colorado of which copper is the sole or even the predominant product of value, but the gold ores of Gilpin County, the deeper ores of Leadville, and all the mixed ores of the San Juan carry small per-centages of copper. In some mines of the last region, notably the Gaston, the iron and copper pyrites alone carry the precious metals. Colorado's output, therefore, of copper, though it be but a by-product, is considerable, being about 8,000,000 lbs. annually. Small as the copper contents be in such pyritiferous ores as the Gaston and certain of the Leadville ores, it is sufficient to collect the precious metals in a matte. This matte, low in copper and rich in iron, is, when roasted by some lead smelters, their most economical flux. Thus at the San Juan smelters in Durango, such ores are smelted raw, with a mixture of lime and foul slag, in order to deprive them simply of the silica and a minimum of their iron, and the resulting matte is roasted and added to the lead charge as a flux, owing to the scarcity of oxidised iron ores. The Silverton Works in the same region are run

xclusively on ores carrying iron and copper ulphides, which are smelted raw with siliceous res and limestone, by what is known as the yritic method.; and the resulting matte is oncentrated, without preliminary roasting, by :-smelting with a further addition of siliceous re. The same procedure is followed by the Bi-Metallic Company in Leadville, and at rorks in Dakota. At Silverton the charge ontains less than 2 per cent of copper in a ompact iron pyrites. Some lime and foul lag, as well as sufficient siliceous ore to bring he sulphur contents of the charge down to o per cent. are added. The pyrites is fed in ery large lumps, as large as the furnace eeder can well push into the centre of the urnace from feed floors on each side of the urnace, level with the feed door. The siliceous re is crushed and fed with the fuel around the valls of the furnace. Smelting is effected in urnaces 36 in. $\times$ 120 in., with 9 feet between loor and tuyeres. The blast has about 18 nches pressure at the blower, and enters hrough twenty-four 2-inch tuyeres. The natte contains, on an average, 20 per cent. of copper. With the cold blast the coke consumption is 1 to 12 of ore. As the blast is heated o 1000° Fahr., the coke consumption falls to as low as 1 to 33. There seems to be no doubt that the hotter the blast up to a degree not yet determined, the lower is the coke consumption, and the higher the concentration. The Silverton slag is said to contain 35 per cent. of silica, 40 per cent. of ferrousoxide, and 15 per cent. of lime. Pyritic smelting is practised with most uniform success at the furnaces of the Bi-Metallic Company of Leadville, where under Mr. Franklin Ballou's able management, after long experience, first with the hot blast and then with cold, a low grade copper matte is made and the precious metals economically collected from a charge containing on an average only about 1 per cent. of copper. As the works are Custom works it is impossible to run upon a uniform charge, and the percentage of sulphur, and the proportion of acid to base are of necessity repeatedly changed within certain limits. Consequently, the consumption of fuel is subject to very wide variations, descending in a typical charge to as low as 3 per cent., and rising to as high as 8 per cent. of the weight of total burden, when the per-centage of sulphur falls below and of silica rises above a normal mixture. The furnaces are the same as those used at Silverton, which were built after Mr. Ballou's model, and the general practice and method of feeding are the same in both cases. Lime is always added. It seems to reduce the risk of scaffolding. But neither the shape of the furnace nor the mixture, nor the manner of feeding, can compensate for lack of skill and experience. Pyritic smelting with a mixed charge is a more delicate operation than cupola smelting with roasted ore and solid carbonaceous fuel, and is not successfully conducted in the United States to any advantage unless under intelligent and scientific superintendence. The general experience there is that sulphuretted ore carrying the proper proportion of silica within itself cannot be treated raw. The sulphuretted ingredients melt by a process of liquation out of the siliceous shell and the furnace rapidly scaffolds. It seems to be essential that the sulphur ore be pure and fed coarse and that the siliceous ore be fine; then as the lumps of pyrites are slowly acted on by the blast in the presence of crushed silica slagging takes place and scaffolding is avoided. At the Bi-Metallic works the concentration of the copper in the first matting is 5 into 1. In the resmelting of the first matte, with siliceous ore, a further concentration of 3 into 1 is effected. It is not, however, pretended by any of the Western works that when replacing the heat derived from the oxidation of carbon by that derived from the oxidation of the sulphur and iron of the charge, though it be supplemented by a hot blast, the furnace is not liable to much greater irregularity in its working than under the old system. Mr. W. L. Austen, of Denver, Colorado, to whom is undoubtedly due the stimulus given to pyritic smelting in America, in his latest patent makes the following remarks:—"It has also been attempted by other inventors to produce the desired conditions by a pre-heating the air of the blast used, in outside heating apparatus, as in iron smelting, but this method did not fulfil the expectation raised, for the blast being rendered intensely oxidising, the formation of accretions in the hearth of the furnace begins at once, and causes various irregularities in the running of the furnace, while the most essential feature, viz., the heat of the smelting zone, is nowise under control. The tuyeres and lower part of the furnace usually become black and clogged soon after coke is omitted from the ore charge."

Austen therefore proposes to introduce regulated quantities of combustible gases, oils, or solids with the blast, and to counteract the tendency to scaffolding by adding lime or dolomite to its charge, and by feeding the silicious ingredient around the walls of the

furnace, and not in intimate mixture with the pyritiferous ores, which with the basic additions are to form the core of the charge.

At all the pyritic works a very large proportion of the sulphur is volatilised, presumably one-half, and burns as a sheet of pale blue flame when it meets the air entering the feed door. This point was made abundantly clear by Hollway in his admirably conducted experiments made in 1878 and 1879, which were as admirably described in his two classical lectures delivered before this Society. His experiments in Bessemerising in a steel converter reached successfully the point where metallic copper formed and chilled his bottom tuyeres. In his further experiments he aimed at effecting a continuous process in a modified cupola provided with a crucible, into which air was driven, and in which the matte, as it entered, was to be concentrated. The heat generated through the oxidation of the sulphur and iron in the crucible, melted the descending charge above. One cause of the stoppage was the enormous quantity of volatilised sulphur which condensed in and clogged up his flues. It was a bold attempt, and came so near succeeding, that it was with profound regret that all who watched its progress heard of the abandonment of his experiment.

More success seems to have attended the pyritic smelting operations of the Cape Copper Company at their mines in Newfoundland than any of the United States smelters have attained. There they separate their ore into two grades; that richer in copper being shipped to the company's acid works in South Wales, that poor in copper being concentrated on the spot in brick furnaces to a low grade matte of about 8 per cent., without the addition of any fuel whatever. The composition of the ore is probably extremely favourable to pyritic smelting, being a compact pyrite with about 8 per cent. of silica intermixed. It is fed coarse into the furnace without the addition of any siliceous mixture, and a low grade matte and very clean slag are tapped. It is claimed that the working of the furnace is as uniform, if not more so, as when carbonaceous fuel is used, and that no particular skill is required. The furnaces, though built of brick, are not unduly corroded by the charge. The addition of silica has not been found to raise the matte or improve the working of the furnace, and the addition of coke, if in considerable quantity, is distinctly deleterious. Single lumps of coke will pass almost entirely unconsumed into the crucible. The particular composition of the ore may be on reason why such pronounced success attend their operation. At the same time, the ver low grade of the matte may bear out th Colorado experience that by raising the tem perature of the blast you raise notably, if no proportionately, the per-centage of the matt product. But a hot blast, unless it can b derived from the waste heat of escaping gases or from the heat of the slag, is costly. Th balance of economy between the cost of fue burnt in the furnace, and of the fuel consume in heating the blast, when it is essential that high grade matte be made, has to be struck a each separate locality by settling the relativ cost of the coke against that of such fuel a may be available for heating the blast. I does not, however, require the gift of prophec to foretell that the Bessemerising of ore an matte, of which pyritic smelting is only a branch, is the direction in which we may lool for the most important improvements in th metallurgy of all sulphuretted ores in the nea future; and there is no reason to suppose tha the converter, with its limited contents, smal charges, and intermittent action, is the appa ratus of final adoption.

Blowers.

Among the adjuncts to the cupola furnac are two which have attained a world wid reputation, namely, the Baker and Roo Blowers. They are both positive, and hol an intermediate place between the blowing engine and the fan. In the Baker blower a cylinder, to which are attached tw fans, revolves synchronously with two hollov cylinders, slotted to admit the blades of the fan. The slotted cylinders serve as stop valves, to prevent the return of the air. In the Root blower two figure-of-eight cylindrical vanes are so constructed that their surfaces are in constant contact, and in contact with the shell during the entire revolution. The Root can be run at a much higher speed than the Baker, and greater pressure can be obtained, an advantage which is, in many quarters, giving it the preference. Root blowers are now being made to give, at 200 revolutions, 4,600 cubic feet of air per minute, at 7 lbs. pressure. As a 5 ton converter consumes from 2,300 to 2,500 cubic feet of air per minute, and as 7 lbs. pressure is sufficient for the shallow trough converter, it is possible that a Root blower can take the place of the blowing engine in a Bessemer plant using converters of that type.

Journal of the Society of Arts.

No. 2,232. Vol. XLIII.

FRIDAY, AUGUST 30, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1896.

The dates fixed for the Society's Examinations in 1896 are—Monday, March 23rd, Tuesday, 24th, Wednesday, 25th, and Thursday, 26th. The last day for receiving applications is Wednesday, the 4th March.

The arrangements of the time table, the subjects, and the prizes offered, correspond with those of the last Examination.

The Practical Examination in Vocal and Instrumental Music will be held in London, commencing June 23rd.

Copies of the Programme, with full details, and an Appendix containing last year's questions and reports by the Examiner's, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

RECENT AMERICAN METHODS AND APPLIANCES EMPLOYED IN THE METALLURGY OF COPPER, LEAD, GOLD, AND SILVER.

By James Douglas.

Lecture IV.—Delivered May 12th, 1895.

The Humid Metallurgy of Copper and the Metallurgy of Lead.

Wet Methods of Copper Extraction.

The humid metallurgy of copper has not been practised to any great extent in the United States, chiefly because there have not been mined any such deposits of ore as those of Spain and Portugal, all of whose constituents can be utilised by treatment in the wet way by such a method as the Henderson. The large deposit of bisulphide of iron accessible to the centres of chemical industry are either practically barren of copper, which is the case with those of Louisa co., Virginia, and of the Davis Mine, Mass., or they supply ores too siliceous to afford a residue of value for iron, which is the case with those of Capelton, in the province of Quebec, owned by American companies, and used for acid making in the United States. The largest consumer of Rio Tinto pyrites in the States is the Pennsylvania Salt Company of Natrona. They treat the cinder by the Henderson process.

Leaching Carbonate of Copper Ores.

The Arizona Copper Company of Arizona have for years been concentrating in a mill of the ordinary type certain of their siliceous carbonate ores. The product is high, and so are the tailings. These they are now leaching with sulphuric acid made in ordinary kilns from their own lump pyrites. This is diluted to 17° B. before being passed through the tailings, which are delivered to the leaching vats directly from the jigs, and are, therefore, free from slimes. The coarse tailings, the coarsest being ½ inch diameter, are deposited in tanks 10 ft. × 10 ft. × 6 ft. None of the ores consist of silica and oxide of copper only, and, therefore, more or less alumina, manganese, and iron are dissolved, which increases the consumption of acid; but this matters the less, as the roasted pyrites from the kilns are copper bearing, and serve as a valuable flux. The elimination of the slimes from the leaching mattes is essential, for their experience coincides with what I have found to be the case, when leaching oxidised ores, that they not only interfere with the uniform percolation, but they prevent the free escape from the leach mass of the liberated carbonic acids, which accumulates around the ore particles and protects them from further action of the acid. At Clifton the copper is precipitated by scrap iron, and the precipitation is effected in revolving barrels, immersed in the copper solvent. The staves of the barrels are made of copper rods secured at suitable intervals in heavy copper heads provided with trunnions. Coarse copper cloth covers the barrels. The precipitation is effected in about half an hour. This form of barrel was suggested by Mr. John L. Thomson, of the Orford Works, but is only one of many ingenious contrivances adopted and most successfully applied by Mr. James Colquhoun, the able manager of the company. The rapidity of

the precipitation ensures a precipitate of extreme purity, which is run down into copper bars with the oxidised copper ores in the cupolas. In California there are near Copperopolis and at Spenceville masses of cupriferous pyrites, whose ores have been treated by heap roasting and leaching. The peculiarity of the Spenceville practice consisted in the precipitation of the copper liquors in large revolving wooden barrels lined with easily replaced wooden blocks and provided with a valve which opened automatically at each revolution to permit of the escape of hydrogen gas. The exclusion of the air so reduced the formation of basic salts of iron that the cement yielded consistently over 80 per cent. The last record of work done at Spenceville, in my possession, shows 492 tons of 84 per cent. cement recovered from 13,715 tons of ore. When the precipitation was complete the contents of the barrel were emptied on a screen, through which the cement copper passed, and from which the unconsumed iron was returned into the barrel. The advantage of the Clifton method is that the iron never escapes from the barrel till completely consumed. On the other hand, the complete exclusion of the copper liquors at Spenceville from the air probably gave a cement of higher grade.

Monnier Process.

But though wet extraction of copper is very little practised, several methods have at one time and another been proposed, which possess metallurgical interest. Mr. Alfred Monnier, over twenty years ago, patented and applied a method for sulphatising copper by roasting the sulphuretted ore with sulphate of soda. The reactions supposed to take place were the formation of bisulphate of soda at the expense of the sulphur of the ore at the beginning of the roast, and the liberation at the close of the roast of the extra atom of sulphuric acid, which sulphatised the copper oxide that had escaped sulphatisation. From the lixivium, the sulphate of soda was crystallised out before the mother liquors were treated with iron for the recovery of the copper; or all the sodic sulphate and ferrous sulphate were crystallised out together after precipitation of the copper. The method was applied at several points on the Atlantic coast, and was adapted to the treatment of gold, silver, and copper concentrates at the Providence Mine, Nevada co., California. There the liquors, after recovering the sulphate of soda by crystallisation, were passed through copper filters, in order to precipitate the silver before precipitating the copper on scrap iron. The cost of recovering the sulphate of soda and the impossibility of sulphatising all the copper, owing to the instability of cupric sulphate in the furnace, presented obstacles to the success of the process.

Whelpley and Storer Process.

A method, which from a chemical point of view is even more interesting than the Monnier, was practically even less successful, viz., the Whelpley and Storer method. It was patented in 1866 but never carried out on a manufacturing scale, though if the reactions were effected by the aid of simpler apparatus than the inventors recommended, it might be made use of. They employed a bath of calcium chloride, and into it threw oxidised copper ore and sulphurous acid from a shaft furnace—the result being the production of calcic sulphate and cuprous chloride which, when precipitated as cuprous oxide by milk of lime, restored to the bath its calcium chloride :—

$$2\,Cu\,O \times Ca\,Cl_2 + SO_2 = Cu_2\,Cl_2 + Ca\,SO_4$$
$$Cu_3\,Cl_2 + Ca\,O = Cu_2\,O + Ca\,Cl_2.$$

Hunt and Douglas Processes.

The late eminent chemist, Dr. Thomas Sterry Hunt, and myself devoted much attention to the humid metallurgy of copper and silver. In our first method, we took advantage of the reaction pointed out by Myer, in 1862, between ferrous chloride and cupric oxide, resulting in the production of cuprous and cupric chloride. The insolubility of the latter necessitated the addition to the chloride of iron of a solvent of the cuprous chloride, such as common salt. Used thus, in conjunction, a bath of ferrous chloride and sodium chloride has given good results when applied to naturally or to artificially oxidised ores. In carrying it out in practice it is found necessary to grind the ore to greater fineness than for a chloridising roast, and that the addition of a small per-centage of salt in the roasting furnace accelerates the oxidisation. The roasting, as in all wet processes, should be conducted at a very low heat and with abundant access of air; a high heat and deficiency of oxygen converting the copper into insoluble compounds, and the iron into magnetic oxide, the production of which in any roast is an unfavourable indication. The leaching is effected in the usual way. The extraction of the copper is slower than in the Henderson process, as it is not affected by mere solution.

The reactions which take place may be expressed by the formulæ :—

$$2\,FeCl_2 + 3\,Cu\,O = Cu\,Cl_2 + Cu_2\,Cl_2 + Fe_2\,O_3$$
$$Cu_2\,Cl_2 + Cu\,Cl_2 + 2\,Fe = 3\,Cu + 2\,F_2\,Cl_2.$$

Much less salt and iron are consumed than in the Henderson process, the saving of the latter reagent being due to the cuprous chloride in solution. If the ore contains arsenic, in the presence of neutral ferrous chloride none enters the solution. The resulting precipitate is, therefore, free from any deleterious contamination, and can be smelted and refined into good copper at one operation. The regeneration of the ferrous chloride is not complete, owing to the formation of basic oxychlorides of iron in the leaching and precipitating vats; but if a sulphuretted ore is under treatment, enough sulphates can be formed in the roast to replace the loss of iron; and the addition of salt to replace the chlorine, if due care be taken to work with closed vats, need not exceed 25 per cent. of the weight of copper produced.

Any metallic copper present is at once attacked by the cupric chloride and converted into cuprous chloride. Large quantities of copper have been made in this way, though it is not at present practised anywhere in the United States.

One reason for its limited applicability is the difficulty of separating silver from the mixed solution. Chloride and sulphate of silver when present in the roast are dissolved simultaneously with the cuprous and cupric chlorides, but the separation of the silver from the solution of copper cannot be effected by metallic copper so long as cupric chloride is present in any quantity; nor by an iodide while cuprous chloride is present. It was while experimenting with sulphurous acid, as a reducing agent, in order to separate the silver from the solution by reducing the cupric to cuprous chloride, that we conceived the idea of separating cuprous chloride as a solid, and using the acid which is simultaneously generated as the solvent. If half an equivalent of chlorine in calcium or sodium chloride or ferrous chloride be added to an equivalent of cupric sulphate in solution, and sulphurous acid injected at a temperature of 70° Centigrade, cuprous chloride separates as a heavy white crystalline powder uncontaminated by any impurity which the solution may contain; and an equivalent of acid is generated for every equivalent of copper reduced.

$$2\,Cu\,SO_4 + Fe\,Cl_2 + SO_2 + 2\,H_2\,O = Cu_2\,Cl_2 + Fe\,SO_4 + 2\,SO_4\,H_2$$
$$(Cu_2\,Cl_2 + Fe = Fe\,Cl_2 + 2\,Cu)$$
$$\text{or, } Cu_2\,Cl_2 + Ca\,O = Cu_2\,O + Ca\,Cl_2.$$

In practice, the separation of the copper in this insoluble form is rapid and perfect, and a large excess of free acid is unavoidably generated. Theoretically, about one part of sulphur should suffice to separate as subchloride four parts of copper; in practice the consumption is nearly one to two, owing partly to the cause above stated, and partly to the escape from the reducing vat of unconsumed gas, especially towards the close of the operation, when the solution of copper has become weak.

Even when treating ores which contain other soluble ingredients than the copper to be saved, and which cause a waste of the solvent, acid can be generated to any extent desired by forcing sulphurous acid mixed with atmospheric air into the chloridised copper solution. If more than a certain proportion of air be present, no cuprous chloride is separated, but acid only is generated, the chlorine compounds in solution acting as carriers of the oxygen in the same way as the nitrogen compounds do in the lead chamber.

This method is now being applied on a large working scale to the treatment of plumbiferous copper mattes carrying the precious metals by the Kansas City Smelting and Refining Company at Argentine, Kansas. The acid is generated from pyritiferous ores in the cylinder furnaces, described in a previous lecture, which are provided with central flues, and with registers to control the admission of air, and consequently the strength of the sulphurous acid. The sulphurous acid may be injected into the copper solution by steam injectors, but, by so doing, the volume of the bath is undesirably increased in bulk. At Argentine the sulphurous acid, after being washed in a coke tower, is forced through a series of three closed vats filled with copper solution by a bronze force pump. Copper solutions, containing from 6 to 8 per cent. of copper, are, in three hours, if the gas be strong, reduced in per-centage to about 1½ per cent. The separated copper falls as a heavy precipitate to the bottom of the tank. Simultaneously more than an equivalent of free sulphuric and hydrochloric is generated. It is impossible to extract from the solution all the copper, inasmuch as cuprous chloride is slightly soluble in sulphuric acid, and freely soluble in hydrochloric acid. The insoluble

cuprous chloride is converted into cuprous oxide by milk of lime, which is collected and washed in filter presses. If metallic iron be used as the precipitant, metallic copper and ferrous chloride are produced. In either case, the chloride can be used to chlorodise fresh cupric sulphate solution. If calcium chloride be produced, it must be mixed with the sulphate solution in a separate vat for the separation of calcium sulphate, which, however, is a valuable bye-product. The process is thus emphatically regenerative. At the Argentine works, the gold, silver, and lead remain with the iron oxide in the residue, and are passed to the lead furnaces.

The Ziervogel-Pearce Method at Argo.

The most extensive establishment in the United States for the treatment, in the wet way, of precious metals in copper is that of the Boston and Colorado Company at Argo, near Denver. Its operations extend back into the sixties, but it was not until the early seventies that Mr. Richard Pearce introduced the Ziervogel method of separating the gold and silver into the works. Incidentally, I may remark, that Pearce, in his presidential address before the American Institute of Mining Engineers in 1869, gives some interesting information as to the nett prices paid for silver year by year, since 1871, till the date of his address, from which some interesting deductions can be drawn as to the ratio in which the cost of reduction has declined with the market value of the metal.

In 1871, silver was worth $1·25, and 65 per cent. only of its value was paid, making it worth to the miner 81 cents. per oz. In 1881, silver was worth $1·13, but 74 per cent. of its value was paid, making it worth 83 cents. per oz. In 1894, silver was worth 62 per oz.; but 95 per cent. of its value is now paid, making it worth 59 cents. per oz. The reduction in the cost of extraction is only one of the many economics which assist the silver miner, as well as the miner of other metals, to meet, and compensate him for the fall in their value.

The process pursued in Argo is to make a mixture of ore, with from two to three per cent. of copper; 40 to 60 ozs. of silver; and ½ to 1 oz. of gold. The steps are to—

1. Concentrate this mixture, 13 into one, in a matting furnace, described in a previous lecture.

2. Concentrate two-thirds of this matte, after roasting with one-third of raw and rich siliceous silver ore, into a matte containing about 60 per cent. of copper, from 700 to 800 ozs. of silver and 10 ozs. of gold.

3. This is crushed to pass a 6-mesh screen to the linear inch, and roughly roasted; then crushed through a 60-mesh screen and given a sulphatising Ziervogel roast before being leached with hot water.

4. Residues contain about 40 oz. of silver per ton, about 10 oz. of gold, and some copper. They are re-smelted with low grade silver-bearing pyrites and siliceous gold ore into a matte containing about 80 oz. of silver and 10 to 15 oz. of gold.

5. This matte is smelted for bottoms, which contain 60 per cent. of copper, about 33 per cent. of lead, 100 to 200 oz. of gold, and about 300 oz. of silver. The pimple metal from the top of the bottoms contains only from 0·1 to 0·2 oz. of gold, about 90 oz. of silver, and 77 per cent. of copper.

6. The bottoms are treated for separation of the gold and silver by a secret process, which, though it has been practised for over twenty years, has never been revealed. The courtesy and frankness with which Pearce and the Company explain every other step of their interesting operations, and the freedom with which they admit visitors to every other part of the works, forbid the stranger from guessing, or, if he guesses, expressing his surmises as to the mysteries which are practised within the sanctuary of the gold-house.

7. The pimple metal is crushed and roasted with sulphate of soda, whereby the silver is much more perfectly sulphatised than by a simple Ziervogel roast. The residue, after leaching with hot water, besides cupric oxide, contains not over 5 oz. of silver. So much of the black oxide of copper is reduced and refined as does not find a more profitable market as oxide. I have reason to think some of it is used by the Standard Oil Company for refining the Lima petroleum.*

The Crook Method at Pueblo.

A method of separating gold and silver from copper matte—of very great interest from a metallurgical point of view, was patented in 1884 by Messrs. J. J. and Robert Crooke, and has been practiced extensively at the Pueblo Company's Works, Colorado. The steps of the process are as follows:—

1. Coarsely ground matte is immersed repeatedly in a bath of lead, maintained at a

* For further details *see* Eggleston, "Transactions of the American Institute of Mining Engineers," vol. xiv. and Pearce, vol. xviii.

temperature below the fusing point of the matte. The first immersion extracts nearly all the gold, and 75 per cent. of the silver. In practice, the desilverisation is effected in four reverbatory furnaces, holding each 25 tons of lead, and built in four tiers on descending terraces. The matte, in charges of one and a half tons, is immersed in the four lead baths successively, from the lowest to the highest. The lead, on the contrary, descends from the highest furnace, where it extracts the least residue of precious metal from the matte, to the lowest furnace, where it becomes in contact with the fresh matte sufficiently charged for desilverisation. As each immersion occupies about one and a quarter hours, and the matte charge weighs about one a half tons, four furnaces, loaded constantly with 100 tons of lead, should treat from 27 to 30 tons of matte daily. To prevent the formation of a lead copper alloy, bars of iron are secured in the bottom of the lead furnace.

2. As I recollect the process conducted some years ago, the matte, saturated with lead, was removed directly to a reverberatory furnace, where, mixed with coal slack, and under a gradually rising temperature, liquidation of most of the lead took place. Under what the inventors claim to be a scorification reaction between the residual lead and the sulphide of copper, there commenced an elimination, in dense fumes, of the sulphur, arsenic, and antimony, and a reduction of the copper and iron to metallic sponge. As the process is described by Hofmann, the desilverised matte is roasted in a calcining furnace till the sulphur contents is reduced to 13 per cent., before being exposed to the scorification and reduction roast. In either case, the product is a metallic sponge, remarkably free from ingredients deleterious to copper; and there takes place the extremely curious and interesting reactions which simultaneously result in the elimination of the volatile constituents of the matte, and the reduction to a sponge of the iron and copper.

3. This sponge is then melted with silica, the iron slagged off, and blister copper produced. The process affords so many operations that it can hardly compete, financially, with simpler methods, but those who have used it are unanimous in pronouncing it perfectly successful from a metallurgical point of view.

Electrolysis of Copper.

The great bulk of the auriferous and argentiferous matte of the United States is treated by electrolysis. In Montana there are two plants, those of the Anaconda and of the Boston and Montana Companies. In the East there are eight, the largest being that of the Baltimore Smelting Company, supplied chiefly with Anaconda matte, whose capacity is 52,000,000 lbs. of copper per year. None of the others approach it in capacity, but their aggregate output is about 150,000,000 lbs. per annum. The main features of the methods used were fully described by Mr. Titus Ulke in Rothwell's "Mineral Industry" for 1893. The details of the methods employed by the several works to purify the electrolyte and to separate the copper and the precious metals from the slimes are not generally published, and, therefore, it would be a breach of confidence to describe even what I do know concerning them. With practice and experience the quality of American electrolytic has admittedly improved; and the treatment charges have declined, owing to the same causes and to the increase in productive capacity. It is therefore becoming remunerative to treat electrolytically copper alloyed with so trifling a per-centage of the precious metals, that the quantity of electrolytic copper entering the market is likely to gradually increase and that of casting copper to steadily decrease; for there are comparatively few ores west of the Alleghanies which do not contain some gold and silver. The day may even arise when Lake mineral will be submitted to electrolytic treatment and the competition between Lake and electrolytic be eliminated. This increase in the production of silver as a bye-product, in copper electrolytic refining, has a notable bearing on the silver problem. The copper ores of Montana without exception contain silver with a trace of gold—probably on an average 45 ozs. to the ton of copper. The Butte copper production of last year therefore represents a silver production of not much under 4,000,000 ozs, which, despite the low price of silver, is through these improved metallurgical methods profitably recovered. The average contents of Lake copper in silver is probably over 15 ozs. per ton, which, if recovered, would add almost another million to the world's silver production.

Bluestone.

Until the introduction of electrolysis as a means of separating the gold and silver from copper, the conversion of copper into bluestone was much more widely practised than at

present; nevertheless, bluestone far in excess of the home demand is made by the metallurgical works at Baltimore, Laurel Hill, and elsewhere. The method of manufacture does not differ notably from that of Europe.

THE METALLURGY OF LEAD.

The lead of the United States comes principally from two regions, the Mississippi and the Rocky Mountains, which yield ores of widely different character. The Silurtan dolomites of Wisconsin and of Missouri and the dolomites of sub-carboniferous age of South Eastern Kansas, contains in places galena and in others galena and blende, deposited in isolated bodies. The lead ores of Missouri and Mississippi and South Eastern Kansas, have been continuously and profitably extracted, despite the absence of silver since the first half of last century, and have maintained their character for extreme purity. While some of the larger deposits are worked by corporations, explorations and mining have always been done to a considerable extent by miners with limited means, and even by farmers in their seasons of slack labour. The contracted scale of their operations; the intermittent supply of ore, and the ability to use crude ore, probably determined, for the treatment of this class of concentrated galena, furnaces of the Carinthian and Scotch hearth types. Of the 37,000 tons of lead which come from this region, and which is about 20 per cent. of the total production of the United States, 19·28 per cent., following the statistics of 1892, is reduced in the blast furnace, 10·61 is reduced in an air furnace resembling the Carinthian hearth, 7·64 per cent. is reduced in a furnace like the Flintshire reverbatory, and 62·47 in Scotch hearths, so modified as to entitle them to the distinction of being American furnaces operated in a distinctly novel manner.

The simpler hearths of this region differ from the old pattern only in that the walls of the well and tuyere back are water-jacketted. Thus the smelting operation is not interrupted at short intervals to permit the hearth to cool. But a much more radical departure from the simple hearth has been made by Mr. E. R. Moffet at the Picher Lead Company's Works, formerly the Lone-Elm Company's at Joplin. The Moffet hearths are built back to back and discharge into a common stack. The lead well of iron is suspended between four pillars and cooled by exposure to the air; while in a hollow back, which forms the partition between adjacent hearths, the blast is heated. This hearth, with the same amount of labour, treats more than twice as much ore as hearths operated by a cold blast. But the per-centage of lead recovered as metal is only half as great. This, however, is an advantage, as the fumes, after being cooled by passing through coils of iron pipe, are forced into and collected in the bags of the Lewis and Bartlett white-lead apparatus. These discoloured fumes, with the rich grey hearth slags and some crude galena, are re-treated in a slag furnace, constructed with double tiers of tuyeres, in which as much lead as possible is volatilised. The fumes issuing from this cupola, after parting from their heavier particles in a brick chamber and flue, are burnt, so as to oxidise suspended carbon dust, and to convert lead sulphide into lead sulphate, before being cooled and forced by a fan into another series of woollen bags. The white lead thus refined is a more remunerative product than the metal. The composition of the Bartlett blue powder and white lead is given by Hofman* as follows:—

	Roasted Blue Powder.	Refined White Lead.
Insoluble	—	0·08
PbSO........	48·76	65·00
PbO	46·82	25·89
QnO	0·27	6 02
Fe_2O_3	0·32	0·03
CaO	0·48	0·02
CO_2	0·90	2·00
SO_2	1·65	—
H_2O	0·37	0·85
Al_1O_3	0·05	—
SiO_2	0·10	—
	99 72	99·89

The slags from the slag eye furnace are said by Holibaugh to be practically clean; and as all the lead fumes from both the hearth and the slag furnace are caught and converted into a saleable product, one of the main objections to the Scotch hearth—its wastefulness—is removed.

The Bartlett process has also been applied in Colorado to the collection of fumes, but the larger per-centage of zinc, and the presence of such impurities as arsenic and antimony, create exceptional difficulties and deteriorate the quality of the product. The Globe Works of Denver are, however, reported to have overcome the obstacles to its successful adoption.

It is in the Rocky Mountains, however, that

* Hofman's "Metallurgy of Lead," p. 115. Holibaugh, *Engineering and Mining Journal*, Dec. 8, 1894.

the metallurgy of lead has enlisted most science and skill in its practice. There, not only are the ores complex, but they are invariably argentiferous, and their lead is almost everywhere used as the absorbent of the precious metals from so-called dry ores, for it is only of late years that copper has been used for a like purpose. As soon as the middle western zone was reached by the Union and Central Pacific Railroads, the rich argentiferous leads of Utah were shipped to England for treatment. But as early as 1869, lead furnaces were erected at Eureka, Nevada, and Utah speedily followed as a lead bullion producer. Soon, however, both were eclipsed by Colorado; where the discovery of the great deposits of Leadville gave her pre-eminence as a lead - producing and smelting centre, which she has never forfeited. Large works were erected in Leadville, but still larger in Denver and Pueblo, which draw lead ores from the remotest mining districts of the south-west and north-west, by virtue of the advantages which quantity, mixture, and the possession of most perfectly trained superintendence and labour confer on that, as on every large seat of metallurgical industry. Mechanical furnaces of almost every type, described in a previous lecture, are used at one or other of the Western lead works to roast ore and matte, but hand furnaces are much more widely retained in lead than in copper works. The smelting furnaces are large cupolas, originally designed on the Raschette model, then verging towards the Piltz, and finally reverting to the Raschette type. They are now so modified in essential details by each smelter that no single furnace can be taken as the exact pattern of the whole. A usual size is now 40 by 120 inches. All are built with a bosh, and all are jacketted within the zone of fusion. Most are provided with an Arents syphon-tap, a discharge built into the crucible wall, and communicating with the bottom of the lead well. In all, the superstructure is supported on pillars to facilitate the removal of defective sections. In most establishments, coke and charcoal mixed is the fuel, but in one instance, at least, uncoked lignite, mixed with coke made from the same, is used very successfully. Most are fed by hand; some through thimbles; others through drop doors. In most cases, only the dust and fume that will collect in long flues is saved; in other cases sheet-iron chambers, with long cooling surfaces, are used; and in at least one, the Bartlett method of filtering the fume through woollen bags is applied. Mr. Mathewson, of the Pueblo Smelting and Refining Company, and Mr. Eurich, of the Aurora Smelting Works, Chicago, have perfected slag taps which, attached to the ordinary water-jacketted furnace, permits a continuous flow of slag, and the maintenance of the liquid charge at a constant level below the tuyères.

Other appliances which struck me as novelties in the Pueblo Smelting Company's Works are the mechanical stirrer, by which the lead is rapidly zinked in the kettles, and the hinged filter, which is dropped, closed, into the kettle and opened, when in the kettle and before it is raised, for the removal of the crusts; also the sprinkling of the crusts with petroleum, and its ignition to effect liquation of the lead.

The following excellent summary of Western lead smelting practice is by Prof. Hofman :—

"As to sampling. This has been brought to great perfection within the past seven or eight years by reason of the fact that a few large smelters, centrally located for ores, fuels, and fluxes, have replaced many of the smaller ones which formerly existed. In the latter, hand-sampling with the ordinary or with improved shovels, like the Brunton sampling-shovel, is sufficient; but in the large works a more rapid and less expensive method became necessary, and machine-sampling was introduced. This consisted at first in separating continuously a small part of a running stream of ore; afterwards it was found better to take the whole width of the stream at short intervals of time. Of the machines for doing this the three representative ones are those of Brunton, Bridgman, and Constant, all excellent. To prepare the sample for the laboratory we have the sample-grinders of the coffee-mill type as made by our leading firms, and the quartering apparatus (laboratory-samplers) of Bridgman and others.

"Coming to the calcination of ores, special attention must be called to the improved construction of the furnaces and to the making up of the charges. In the stationary hearth furnace, besides increasing its inside width to 16 feet, the roasting hearth has been separated from the fusing hearth by a vertical flue, and the area of the vertical section of the latter has been made smaller. The products of combustion passing from the fireplace over the small fusing hearth rise in the flue, and then suddenly expand, filling the entire width of the roasting hearth. Thus it has been made possible to keep a high heat in the fusing

hearth, and a low heat in the roasting hearth, and to let the latter discharge into the former. With mechanical rabbles the roasted ore is collected in a hopper, which is emptied at intervals into the slagging hearth. In the making up of roasting charges new problems had to be solved. In foreign works the ores to be slag-roasted are galena concentrates rich in lead, while the sulphide ores which our Western smelters have to treat are usually mixtures, low in lead, of pyrites, blende, galena, &c., and gangue. To slag these requires a high temperature, which is liable to cause loss of lead and silver by volatilisation; and as an entirely satisfactory method of condensing the fumes from a slagging furnace has not yet been devised, the only way of reducing the loss seems to be not to slag charges containing over 10 per cent. of lead, and 100 ozs. of silver to the ton—some metallurgists say even less.

"In the shaft furnace, the form and the material used are much alike at all works. While 42 inches × 120 inches is now a common size, some smelters think 33 inches × 100 inches the most favourable for doing clean and cheap work. Formerly, the standard distance between the tuyères was 36 inches. The natural tendency to increase the capacity of the furnace prompted its extension to as much as 60 inches, water-cooled tuyere-nozzles being allowed to protrude through the water-jackets, so as to make the actual distance 48 inches. The pressure from the strong blast necessary to penetrate a charge of such thickness made the heat in the furnace creep up, with the result of excessive loss in metal. This caused a reaction, and the distance was reduced in some instances to 30 inches; at present it varies from 33 to 42 inches. Some furnace men think 120 inches too long for a furnace, and do not like to exceed 100 inches.

"In the management of a furnace, beside the making of a correct slag, its separation from the matte, especially with zinky ores, and the collection of flue-dust, have given much trouble, and are still doing so to some extent.

"For the collecting of fumes, the simple and effective manner of cooling the walls of dust-flues and dust-chambers in use at the Grant and Omaha Works, Denver, Colorado, should not be overlooked. I refer to the use of hollow bricks through which air circulates. It is a simple and excellent way of surmounting one of the principal difficulties in condensing flue-dust, namely, the cooling of the gases; the other, the retarding of the current, has been happily dealt with by Freudenberg. In the management of the furnace special stress must be laid on the fact that the making up of the charge is now almost wholly governed by chemical principles, instead of mere experiments as in former years. For this introduction by a scientific instead of an empirical method the American smelter can take much credit to himself.

"The improvements made in the desilverisation by the refiner are in no degree inferior to those made by the smelter, and have been along the same line. The distribution of precious metal in the base bullion has been carefully studied, and methods of sampling have been devised which are accurate and quick. Here, also, in some instances, machine work has replaced hand work. In the general arrangement of plant, the apparatus and its management are so planned that the base bullion, when charged into the softening furnace at the top of the works is not handled again until it is ready to be loaded at the lower end, as refined lead, into the cars. The bars are moulded, not by ladling, but by some of the simple mechanical devices for that purpose. The capacity of the desilverising kettle, by which that of the remaining apparatus is regulated, has been increased from the original 12½ tons to 30, and in a few instances to 45 and 50 tons. The kettle is discharged by that simple and beautiful invention, the Steitz syphon. The manner of working is being continually simplified. To-day, base bullion, running 300 ozs. silver and gold to the ton, is desilverised by two zinkings, if no separate gold-crust is to be made; otherwise by three. The liquation of the crusts has also been greatly improved; and retorting, although invented by Parkes many years ago, only became the established method of work after it had been perfected here by Balbach. In cupelling, the principle of the English furnace has been adhered to; but the form, size, filling, and manner of support of the test, the apparatus for blowing, the mode of working, &c., all have been so changed and improved as to make an entirely new furnace, suited to the daily increasing demands made upon the refiner. In the record of improvements the working up of by-products must not be forgotten. This is now done as fast as they are made, thus leaving only a comparatively small amount of metal circulating in the works."

Conclusion.

As I said at the outset, it would be impossible, in the compass of four lectures, to give you more than a mere statement of the influences and the controlling causes which have impressed its character on American metallurgy, and a summary of the mechanical contrivances and processes by which it has been possible, with financial success, to reduce from their ores the metals of which we have been treating.

I have endeavoured, from amidst the multitude of novel appliances and practices which bid for public favour, to select those which are distinctly of American origin, and have commended themselves, more or less, to general acceptance. But, from the hasty review of American departures from European precedents, it will be seen that though our metallurgists cannot claim the honour of any great metallurgical discoveries, they have brought to bear on the practice of their profession acute ingenuity in devising new machines, and in altering machinery and methods, so as to adapt them to their altered surroundings. The high price of labour, co-incident in some instances with very lean ore, has necessitated the adoption, wherever possible, of automatic machinery, arranged, so to speak, consecutively, which does its work very cheaply, if not very perfectly. The distance from a market has excluded our metallurgists from taking advantage of certain economies which materially assist their foreign rivals, notably in the saving and utilisation of bye-products. The cost of fuel, and sometimes of fluxes, makes it at times more profitable to lose than to save. How far it is right to waste nature's resources, in order to realise immediate profit, is a matter for the economist and the legislator to decide. The metallurgist of America, while fully conscious of the imperfections of his practice, having, nevertheless, set before him the task of developing with profit the mineral resources of the country, has fulfilled it, by dint of enterprise and originality—wastefully, it may have been sometimes, but yet successfully. Where, however, through improved means of transportation, fuel and fluxes have become accessible, he has shown, as in the case of lead smelting in Utah and Colorado, that though in the early days he reluctantly adapted himself to circumstances, and, in order to make lead at all, had to make foul slag, to-day he can make his profit by doing work so excellent, from both the theoretical and practical points of view, that it may safely challenge competition with the best performances of Europe.

When we take a retrospective glance over any metallurgical enterprise, surprise is the predominant feeling, that it has been possible to meet the extraordinary decline in values which has been witnessed in the United States during the last fifteen years. The shrinkage has been even more excessive on the other side of the Atlantic than on this. At that date custom duties were at their maximum, and the full tax on imports was operative, because production was not in excess of the home demand. Since then the duty has been lowered on all metals; it has been entirely removed from copper, and owing to the excessive production it has ceased to be possible to realize in the case of any domestic metal the full benefit of the protection extended to it. The result is that this artificial value, now in whole or in part lost to the producer, has to be added to the universal decline, in estimating the gross reduction in price which the American miner and metallurgist has been compelled to meet. Nevertheless neither the mines nor the furnaces have been permanently closed. On the contrary, production of some metals has increased as price has declined. To a certain extent the decline in value has been the cause of the increase through the necessity imposed on corporations to maintain, if possible, a certain gross profit on a constantly shrinking per ounce, or per pound, or per ton profit. But the miner would long ago have plunged over the slender margin of profit into the abyss of loss had the remedy for depleted value been simply increased production. The real remedy has been the introduction of better machinery and better methods, not only by the miner and metallurgist, but by all subsidiary industries.

It is due to these same causes that the railroads have been able to aid him by heavy reduction in rates. All these influences are still operative, some of them with accelerated activity, since fuller knowledge of the laws which govern, and the invention of machinery to control, electricity has enabled us to harness that ubiquitous force to our mine hoists, pumps, and rock drills, and to our mills and our furnace plants.

As machinery is improved and more widely applied, hand labour is of course dispensed with. But the social and political results of thus reducing the field of human employment has not heretofore been severely felt, inasmuch as the total number of operatives has been actually augmenting when trade is in its

normal state. This is due to the fact that the growth of manufacturing has been so rapid that the diminution of manual energy through the introduction of machinery has not kept pace with it; for if the same number of hands makes, with the aid of machinery, twice the former quantity of any commodity, but the quantity demanded is four times as great, twice the number formerly employed will find occupation. So long as this expansion proceeds, opposition is not actively and violently exerted, as it otherwise would be, by labour organisations, against the replacement of hand labour by machinery. Although labour troubles in the States have been acute, they have not often been excited by that cause. In this respect the American miner and metallurgist has a decided advantage over his European competitor. The floating character of his labour, paradoxical as that may seem, operates in his favour. In Europe workmen, highly-skilled and competent as craftsmen, have been employed, if not in the same works, in the same neighbourhood, for generations, and have acquired a certain inherent though unacknowledged interest in the local industries. Their employers can hardly help recognising this. From such sympathetic trammels an American employer of labour, especially in the West, may not be entirely free; but he is much less encumbered by them than a European manufacturer. He can increase or diminish the number of his workmen as self-interest dictates, and seldom feels scruples or meets with opposition. While he is himself but little trammeled with precedents and prejudices, he can employ men willing to work as he may dictate. They may be less skilful handicraftsmen than the trained operatives of Europe, but they are apt to learn and content to use any tools put into their hands. The introduction of machinery can therefore be much more easily effected and its full efficiency evolved than in European works.

Miscellaneous.

BELGIAN COMMERCIAL MUSEUMS.

Manufacturers have, for a long time past, sought means to combat commercial crises by extending the field of commercial activity, and by seeking new outlets for national products. It was thought that the establishment of commercial museums would guide manufacturers as to the taste and needs of consuming countries, and would contribute to the direct purchase by these countries from the producing countries. Hence the origin of the commercial museums in Belgium, Germany, and Austria-Hungary. M. Henri Blancheville, who was sent on a mission to Belgium, Germany, Austria-Hungary, and Switzerland, for the purpose of studying commercial museums and other institutions tending to favour the development of the export trade of those countries, has addressed a report to the French Minister of Commerce. Speaking of the Belgian museums, he says that the Commercial Museum of Brussels has been in existence about eight years. It occupies the whole of a vast building, which belongs to the Government. The staff forms part of the actual staff of the Department of Foreign Affairs, to which commercial matters are referred. One department—that of transport—is entirely under the Ministry of Railroads. The primary aim of the museum was to collect and centralise samples of merchandise sold in foreign markets by competing countries, and to place these samples at the disposal of Belgian producers who would desire to have their manufactures conform to the exigencies of foreign markets. Moreover, they bore the indication of their origin, of their wholesale purchase price, with the additional cost of transport, customs' duties, &c., the manner of packing, the retail price, and the average quantity sold in the market. The museum was also to receive patterns of original materials of foreign produce, the direct purchase of which by Belgian manufacturers might offer an advantage, instead of having recourse to the intermediate markets of Europe in England, Germany, and France. It even collected cereals from the Balkans, intended to compete with similar products of other countries of Europe or of the United States. These various samples of raw material, as well as of manufactured articles, were sent to the museum by the agents of the Belgian consular staff. It was not long before this collection of samples was supplemented by a Department of Information. This information relates to the greatest variety of subjects, and embraces all countries—statistics of the imports and exports of foreign countries: their present financial and commercial condition; their needs, commercial usages, methods of payment, credits, rates of exchange, ways and means of transportation, customs' tariffs, and different expenses; principal commercial houses—whether according to lists furnished by the consuls, or according to the National Annual Reports—such is the character of the information asked for. This department has been greatly extended, and now furnishes information to nearly half the visitors to the museum. One of the sections of the Brussels Museum is devoted to contracts, as much for the department of the Belgian Government (railways, bridges, posts, telegraphs, public works, hospitals, and prisons), as of foreign Governments. The section holds at the disposal of those who are interested the estimates and other information useful in tenders for contracts. These statements emanate from the

Consuls who have received from the Department of Foreign Affairs detailed instructions on the subject. This part of the museum is highly appreciated by the public and attracts one-fourth of the public. Another branch of the department not less appreciated concerns transportation, especially transportation by sea. This section is not strictly a part of the museum, but it was attached to it for the convenience of the public. It is also connected with the railway department of the Government and furnishes either immediately or in two or three days the information asked for as to the means of transportation, freights, shipping lines, &c., from a Belgian port to one in any part of the globe. When the required information is not at hand application is made to shipping companies at Antwerp who supply it by return of post. From whatever section information is furnished it is given gratuitously by the museum, the staff of which endeavour to satisfy every inquiry addressed to it. For the operation of these various departments, besides the sample halls referred to above, which are free of access, the museum possesses a certain number of bureaus belonging to the departments enumerated, to which visitors are referred. The visitors are registered as soon as they enter a particular department. In each of these bureaus there are one or more clerks to furnish the explanations required. Finally the museum has a library and reading-room, where persons may study from 9.30 until noon, and from 2 to 5 o'clock. The *personnel* of the museum, not comprising that of the transportation section, includes one director, a chief clerk, two ordinary clerks, three subordinate *employés*, and four messengers. These are paid out of the funds of the Ministry of Foreign Affairs. The museum publishes a weekly journal called the *Bulletin du Musée Commercial*, which is edited by the staff of the institution. The amount received from subscriptions and advertisements covers certain of the expenses of the museum. On the whole, says M. Blancheville, the Commercial Museum at Brussels exists and prospers rather through the annexed departments created later by it, than through the section of samples or patterns. The term "museum," therefore, is somewhat incorrect; it is rather a bureau of information, excellently supplied, and, in short, it is the information disseminated by it that the industrial and commercial world of Brussels appear to thoroughly value.

THE FRUIT AND DAIRY INDUSTRIES OF PERSIA.

In variety of species and richness of flavour the fruits of Persia compare favourably with those of any country in the world; in fact, the Persians, according to the United States Consul at Teheran, think that there are none to equal them. Those found in great abundance are the black and white mulberry, cherries, apricots, greengages, plums, peaches, nectarines, damsons, apples, pears, dates, oranges, limes, lemons, citrons, cedras, pomegranates, figs, grapes, quinces, and water-melons. Strawberries are grown in small quantities, but raspberries can scarcely be said to exist. Gooseberries, and black, white, and red currants are not found at all, and pineapples exist only in one or two greenhouses and for private consumption. Persian dried fruits consist of walnuts, filberts, pistachios, sweet and bitter almonds, raisins, currants, dates, and figs. Most of the plums, especially the *magnum bonum*, are dried, and the latter are exported in large quantities to Russia. The principal fruits exported are dates, figs, currants (dried), raisins, walnuts, filberts, pistachios, sweet and bitter almonds, oranges, lemons, and citrons. Russia is the chief market for fruits exported from Persia, with the exception of dates, which are sent to most countries of the world. Although the Persian dates are not equal to those grown and shipped at Bussorah, on the Tigris, they are sufficiently appreciated to secure a steady demand. Raisins, bitter almonds, and pistachios are also sent as far as England. Jams and preserved fruits are prepared by the natives to a considerable extent but only for local consumption. They are generally too sweet and insipid for the foreign taste. Persians have a decided fondness for sweet things, and to such an extent is this carried in jams that the natural flavour is almost lost. In addition to the various kinds of plums, jams are made of cucumbers, pumpkins, carrots, radishes, apples, pears, quinces, the outer skin of almonds, and orange, lemon, and citron peel. As regards the dairy industry, dairy products in Persia are prepared by much simpler processes, and are less nutritious in quality than those which we are accustomed to in western lands. The milk is supplied by the cow, buffalo, sheep, and goat; and as the herbage of the grazing grounds in summer is scant and the forage provided for the animals in the winter not over nutritious, the fatty matter is not presented in a very high degree. The Persian dairyman does not usually allow his milk to stand long enough to produce cream, which is seldom in demand, except by a few Europeans; but as soon as the milking is finished such as is not required for cheese is converted into a rather acid curd called "most." This process is effected by the application of a small quantity of the same preparation from the previous curding. In order to extract the butter the curd is broken up and mixed with about double the quantity of water, namely, one quart of curd to two quarts of water. The whole is then put into the churn or whatever serves its purpose. When large quantities have to be handled, a sheep or goat's skin, sewn up like a sack, but open at the neck for filling or emptying, is the contrivance used. A cord is then tied to each end of the skin, which is suspended between two posts, and shaken backwards and forwards until the butter is formed. The butter comes after five or six hours agitation. After the butter has been extracted from the milk, it is put into a large copper vessel over a

fire and heated, in order to expel the superfluous moisture. When this operation is finished, the butter is put into goatskins, and sent to market under the name of "rogan." It is used entirely for culinary purposes, especially in stews eaten with rice. The buttermilk, or the mixture of buttermilk and water, after the butter has been extracted, is a favourite beverage with the Persians. It is called "dook," and is drunk regularly at both luncheon and dinner. In the summer, with the addition of a piece of ice, it makes a refreshing drink. Another preparation obtained from the "most," or sour curd, is called "kashk." This is made by boiling the curd down until it becomes a stiff consistency. It is then exposed to the sun to dry, when it becomes as hard as chalk, which it resembles very much in appearance. It is soluble in water, and gives to some culinary preparations an acid, though not an unpleasant flavour. It is, however, much more appreciated by the natives than by foreigners. Persian cheese, called in the native tongue, "Panir," is nothing more than the raw curd. After being taken from the vessel in which the process of curing has been carried on, it is hung up in a cloth for three or four days to drain, and when taken down it is in its marketable state. In districts remote from towns it undergoes a longer process of drying, and for the purpose of transport is sewn up in goat skins. Most of the cheese and "rogan," or clarified butter, is prepared by the nomad tribes, who are the possessors of large flocks of sheep and goats, which they graze during the summer on the mountain slopes. A few cows are kept in Teheran for the supply of milk and butter to the Europeans. European canned butter is imported into Persia but not to any great extent. It is usually a Swiss or Swedish preparation and the quality is not always the best. Cheese is largely imported from Russia and Holland and also from England.

General Notes.

Dairy Farming.—Under the presidency of the Earl of Derby, an effort is being made by the British Dairy Farmers' Association to give a helping hand to dairy farming, and its allied industry of poultry raising. At the twentieth annual London Dairy Show, to be held at the Royal Agricultural Hall in October next, prizes to the value of £2,515, in addition to 142 gold, silver, and bronze medals, are offered for competition in 451 different classes. The Association have this year been supported by contributions to the prize fund from the Corporation of the City of London, the Poulters' Company, the President (Lord Derby), Mr. Titus Barham, Sir James Blyth, Bart., and others, the last-named gentleman giving £400 as prizes for plans and models of dairies adapted for the manufacture of butter and cheese.

Swiney Lectures on Geology.—A course of twelve lectures on "The Geological History of Man" will be delivered by J. G. Garson, M.D., V.P. Anthrop. Inst., in the Lecture-theatre of the South Kensington Museum, on Mondays, Wednesdays, and Fridays, at 5 p.m., beginning Friday, 4th October, and ending Wednesday, 30th October. Each lecture will be illustrated by means of lantern slides and lime light. The lectures are given under the direction of the Trustees of the British Museum. Admission to the course is free. Owing to want of room, the site of the lectures has been removed from the British Museum (Natural History) to the South Kensington Museum.

Motor Carriage Competitions.—The *Engineer* newspaper offers the sum of 1,000 guineas in two or more prizes for public competition upon one of the main roads of the kingdom. The rules and details of the competition, and the names of the gentlemen who have consented to act as judges, will be given out at an early date. In America the Chicago *Times-Herald* offers 5,000 dols. (£1,000) to be awarded in a race between Milwaukee and Chicago. The contest will take place about the 1st of November. The first prize will be 2,000 dols. and a gold medal, the same being open to the competition of the world; second prize, 1,500 dols., with a stipulation that in the event of the first prize being awarded to a vehicle of foreign invention or manufacture, this prize shall go to the most successful American competitor; third prize, 1,000 dols.; fourth prize, 500 dols. The third and fourth prizes are open to all competitors, both foreign and American.

The European Silk Crop of 1895.—According to the latest estimates of the silk production of Western Europe as furnished by the *Bulletin des Soies et Soieries de Lyon*, the approximate quantity of cocoons in 1895 in France, Italy, and Spain is expected to amount to 49,000,000 kilogrammes (kilogramme = 2·204 lbs. avoirdupois) as compared with 55,337,000 kilogrammes in 1894. In Spain it has been estimated by the French Chamber of Commerce of Valencia that the weight of cocoons will exceed 1,200,000 kilogrammes, about 10 per cent. more than the crop of 1894. As regards Italy it appears from information supplied by the authorities in that country that the crop would be about 38,500,000 kilogrammes of cocoons against 43,650,000 kilogrammes in 1894—a falling off of about 11 per cent. In France it results, from inquiries that have been made by the syndicate of silk merchants in Lyons, that in 586 of the most important silk-producing communes the quantity of cocoons declared has been stated at 4,503,574 kilogrammes, as compared with 5,186,446 kilogrammes in 1894—a diminution of 13 per cent. The principal silk-producing department of France is Gard; then follow in the order named Ardêche, Vauchise, Drôme, Var, Isère, Bouches-du-Rhône, and Herault.

Journal of the Society of Arts.

No. 2,233. Vol. XLIII.

FRIDAY, SEPTEMBER 6, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1896.

The dates fixed for the Society's Examinations in 1896 are—Monday, March 23rd, Tuesday, 24th, Wednesday, 25th, and Thursday, 26th. The last day for receiving applications is Wednesday, the 4th March.

The arrangements of the time table, the subjects, and the prizes offered, correspond with those of the last Examination.

The Practical Examination in Vocal and Instrumental Music will be held in London, commencing June 23rd.

Copies of the Programme, with full details, and an Appendix containing last year's questions and reports by the Examiner's, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

TEN-VOLUME INDEX TO "JOURNAL."

The new Index to the *Journal of the Society of Arts*, for volumes xxxi. to xl. (1882-1892), is now ready, and can be obtained by members on application to the Secretary, John-street, Adelphi.

Some copies of the three previous ten-volume Indexes are still in stock, and can also be obtained by members on application.

The price to non-members of each Index is Half-a-crown.

Miscellaneous.

ART EXHIBITIONS OF THE SOCIETY.

In the article on "Early Art Prizes of the Society" (No. 2,228, August 2, 1895) reference is made to the exhibitions of pictures, &c., which grew out of the system of premiums, and eventually led to the foundation of the Royal Academy. As the institution of picture exhibitions in this country is a subject of considerable interest, it is thought that some further particulars respecting the early history of the movement will be of interest to the members.

The first idea of an exhibition appears to have occurred to the Committee of Polite Arts as a means of showing to the public the objects which were successful in obtaining prizes, and these objects were thus publicly exhibited by the Society for several years. Coincident with this desire was the movement among the artists for some system of interesting the outer world in their work. There were, at the period of the foundation of the Society of Arts, few facilities for the education of the artist, and none at all for the making widely known the objects he produced. In St. Martin's-lane there was an old-established resort of painters, which was known as the St. Martin's-lane Academy, and from this institution emanated the demand for an exhibition. It appears from the Minutes of the Society of Arts that on February 27th, 1760, "A letter from Mr. Francis Hayman, Chairman of the Committee of Artists, was read, desiring the use of the Society's room for exhibiting paintings, &c." The letter was referred to an extensive and important committee, including among its members Israel Wilkes, Mr. Pine, Sir George Savile, Lord Ward, P. Carteret Webb, Mr. Chambers, Lord Middleton, Sir Thomas Robinson, Thomas Hollis, Dr. Knight, and Henry Baker. The committee reported on March 5th that "they are of opinion that the Society may allow a Public Exhibition of Productions in the Polite Arts for one fortnight this year under such regulations and restrictions as the Society shall hereafter prescribe." The following regulations were then passed:—

1. That this Exhibition be confined to the productions of the artists resident in Great Britain or Ireland.
2. That all the productions in the Polite Arts coming from the Committee of Artists be received.
3. That the productions of all other artists in the Polite Arts be also received.
4. That no production be received except the name of the artist be sent therewith.
5. That such productions be exhibited from the 21st day of April to the 3rd day of May next, both inclusive.

It was also decided that no charge should be made for admission, and further resolved that "a Committee of the Society be appointed to view the productions of the Polite Arts (not coming from the Committee of Artists) before they are put up in the Society's apartments. That the said Committee have power to reject such pieces as they may think unbecoming their dignity to have exposed under their permission. That the said Committee may appoint the places where all the productions may be hung or exhibited, in case any dispute shall arise among the artists about placing them." It was then "ordered that the artists be acquainted that their proposition is

accepted of, except that part which relates to taking the shilling at the doors."

It will be seen from these resolutions that, although the Society accepted the proposition of the artists for an exhibition, they took care to reserve to themselves all the arrangements; so that it was, in fact, the Society's exhibition.

It is interesting to note in this connection that, in 1753, at the same time as the Society of Arts was initiated, the artists, under the chairmanship of this same Francis Hayman, attempted, without success, to form an academy. The official notification of the meeting, held on November 13th, is as follows:—"There is a scheme on foot for creating a public Academy for the improvement of painting, sculpture, and architecture, and it is thought necessary to have a certain number of professors with proper authority in order to making regulations, taking subscriptions, &c., erecting a building, instructing the students, and concerting all such measures as shall be afterwards thought necessary. Your company is desired at the Turk's Head, in Gerard-street, Soho, on the 13th November, at five in the evening, to proceed to the election of thirteen painters, three sculptors, one chaser, two engravers, and two architects, in all, twenty-four, for the purpose aforesaid, (*signed*), Francis Milner Newton, *Secretary*." The names proposed were as follows:—

Francis Hayman, *Chairman*, George Michael Moser, Louis Francis Roubiliac, Thomas Hudson, George Lambert, Samuel Scot, Robert Strange, John Shackleton, William Hoare, Charles Grignon, John Ellys, Henry Cheere, Isaac Ware, Richard Dalton, James Payne, Joshua Reynolds, Samuel Wale, Gavin Hamilton, John Gwynn, Thomas Sandby, Richard Yeo, Thomas Carter, John Astley, John Pine, F. M. Newton, *Secretary*.* No agreement was come to at the meeting, and the projectors were satirized by their fellow artists, and became the objects of several caricatures. It will be noticed from the above list that some of the twenty-four were among those who obtained premiums from the Society of Arts, and several were afterwards foundation members of the Royal Academy instituted in 1768.

To return to the Exhibition of 1760. There were 130 works in all, and the best artists were well represented. Reynolds had four portraits, Richard Wilson three landscapes, Hayman his well-known picture of Garrick as Richard III., and Cosway the portrait of Shipley. Among the other celebrated exhibitors may be mentioned Highmore, Morland, Pine, Sandby, Carlini, Moser, Pingo, Roubiliac, Wilton, MacArdell, Gwynn, Rooker, Strange, and Woollett. The title of the catalogue, which was sold for sixpence, was "A Catalogue of the Pictures, Sculptures, Models, Drawings, Prints, &c., of the present Artists, exhibited at the Great Room of the Society for the Encouragement of Arts, Manufactures, and Commerce, on the 21 of April, 1760."

* Rimbault's Soho, 1895, pp. 194-5.

It must be borne in mind that the great room here referred to is not the present meeting room in the Adelphi, but a former habitation of the Society, situated in the Strand, near Beaufort-buildings. The present building was not taken possession of until the year 1774. The Exhibition was a success, but, unfortunately, a success which led to disaster, for a disagreement arose among the exhibitors as to the use to be made of the money received at the door in exchange for catalogues. This amounted to one hundred pounds. In an article on "the Royal Academy in the last century," Messrs. J. E. Hodgson and F. A. Eaton wrote:—"That was a very remarkable sum of one hundred pounds, one of the most remarkable recorded in history; it revealed a new source of wealth, a money-making power hitherto unknown."* In consequence of the split there were two exhibitions in 1761, and in several following years. The chief artists seceded, and formed themselves into the Society of Artists of Great Britain, which exhibited in Spring-gardens, and the Society of Arts continued its patronage to the others, who subsequently styled themselves the Free Society of Artists. Each body took credit for the Exhibition of 1760, and counted its own one of 1761 as the second Exhibition.

Francis Hayman, on the 9th December, again wrote as Chairman of the Committee of Artists in St. Martin's-lane, to solicit the use of the Society's room for a second exhibition, when a committee was appointed by the Society and leave was given. Amongst the contributors to this exhibition, held in 1761, were R. E. Pine, J. Highmore, D. Serres, T. Keyse, R. Cosway, Nollekens, and Pingo, but these names contrast unfavourably with the number of distinguished artists who contributed to the Exhibition of the Society of Artists of Great Britain, which will be referred to later on. Notices are printed on the catalogue of the Society of Arts Exhibition to the effect that "the money arising from the sale of these catalogues will be given by the artists immediately after the exhibition to some public charity," and that "those pictures marked thus × were candidates for the premium given for historical and landscape paintings." The institution of these public exhibitions appears to have been rather doubtfully regarded by some on account of the unruly conduct of the public who were admitted free. At first it was resolved that two constables should be in attendance, but afterwards four were determined on, and at a meeting on May 20th, 1761, it was resolved, "that a discretionary power be given to Mr. Blake to employ eight or more constables, and to give such orders as he shall think requisite relative to the exhibition." The precautions would seem to have been needed, for on May 27th thanks were voted to "Mr. Blake for his great care and diligence during the late exhibition of the works of the artists, in preserving the peace and suppressing many tumults and dis-

* *Art Journal*, 1889, p. 133.

orders which had happened, and for using proper and prudent methods to prevent the continuance and increase of such disorders."

A third exhibition of "Paintings, Sculptures, Models, Drawings, Engravings, &c.," in the Great Room of the Society of Arts, in the Strand, was held in 1762. Among the exhibitors may be mentioned D. Serres, T. Keyse, R. E. Pine, G. Bickham, R. Earlom, J. Gandon, T. Worlidge, J. Nollekens, J. Bacon, Van Nost, J. and L. Pingo, Kirk, and Cosway. A fourth exhibition, said to be "under the patronage of the Society of Arts," was held in 1763. The most distinguished exhibitors were John Bacon, James Basire, George Bickham, R. Cosway, James Gaundon, J. A. Gresse, T. Keyse, John Mortimer (Edward the Confessor spoiling his mother at Winchester: this was the second premium for history painting [fifty guineas] for the year), R. E. Pine (Canute reproving his courtiers for their impious flattery; the first premium [one hundred guineas] for the year), T. and L. Pingo, and George Romney (the death of General Wolfe; this picture was adjudged a bounty of twenty-five guineas), D. Serres, John Shackleton (principal painter in ordinary to the king), and William Woollett.

A fourth exhibition was held in 1764, which contained contributions from R. Cosway, Dance, Gresse, Keyse, Romney, Serres, Mortimer (St. Paul preaching to the ancient Druids in Britain. The first premium in history-painting [one hundred guineas] for the year was awarded to this picture), Bickham, Pingo, Kirk and Bacon. About this time, there seems to have been some dissatisfaction and a desire among some members of the Society to discontinue the exhibitions. On February 29, 1764, a motion was agreed to "that it be an instruction to the Committee on Exhibitions to treat for a room for the exhibition, not exceeding the sum of £84." A satisfactory place does not appear to have been found, and the exhibition was held in the Society's room, but when the question of an exhibition for 1765 arose, the proposal was negatived, and the exhibitions in the Society's room ceased.

An exhibition was held in 1765 "by the body of artists associated for the relief of their distressed brethren, their widows and children," at "Mr. Moreing's Great Room in Maiden Lane, Covent Garden." In 1766, an exhibition was held at the same place, but in 1767, the body now styled the Free Society of Artists moved to "the two new Great Exhibition Rooms in the Pall Mall, near the bottom of Hay Market." On the catalogue for this year the following notice is printed:—"From the commencement of this association not a single member afflicted with sickness, &c., ever applied in vain, they have been relieved with from three, five, ten, to fifteen and twenty guineas each, and besides the cash in the Treasurer's hands this Society hath now in the Bank six hundred pounds three per cents. which cannot be alienated from the purposes in the plan on any pretence whatever." In 1767, the Free Society removed to "Mr. Christie's new Great Room next Cumberland House, Pall Mall." Cumberland House was afterwards the Ordnance-office, and is now part of the War-office. The exhibitions of 1770, 1771, 1772, 1773, and 1774 were held at the same place. In 1775 the artists moved to "their Exhibition Room and Academy in St. Alban's Street, Pall Mall," where they exhibited in 1776, 1777, 1778, and 1779. In 1783, the Free Society exhibited at "No. 28 in the Haymarket," but it was then in a decayed state, and prefixed to the catalogue of this, its last year, is this notice, "This Society claims the merit of being the first who produced an Exhibition in this country; it ranked among its exhibitors the most respected painters, engravers, and some of the first architects, but the fascinating charm of a Royal Exhibition induced many to desert it, and the false delicacy of some were hurt by the plan being founded for the purposes of charitably contributing to relieve the distresses of their brother artists. The public, however, have seen the institution in its proper light, and from the first to the last have afforded the warmest encouragement, and not withheld their powerful patronage."

Some notes must now be made of the exhibitions of the Society of Artists of Great Britain, who left the Society of Arts and went to "the Great Room in Spring Garden, Charing Cross." It is not quite certain where this room was situated, but it is supposed to be now incorporated in the offices of the London County Council. As previously stated, the chief cause of the split among the artists was a dispute as to the use to be made of the money obtained from the sale of the catalogues; but it is evident that the ruling of the Society of Arts, that no charge should be made for admission, had much to do with the decision of the chief artists to go elsewhere, for in the preface of the catalogue of the Society of Artists for 1762, which was written by Dr. Johnson, we read:—"Of the price put upon this exhibition some account may be demanded. Whoever sets his work to be shewn naturally desires a multitude of spectators, but his desire defeats its own end when spectators assemble in such numbers as to obstruct one another. Though we are far from wishing to diminish the pleasures or depreciate the sentiments of any class of the community, we know, however, what every one knows, that all cannot be judges or purchasers of works of art, yet we have already found by experience that all are desirous to see an exhibition. When the terms of admission were low, our room was throng'd with such multitudes as made access dangerons, and frightened away those whose approbation was most desired."

These remarks form a curious commentary on the precautions found necessary by the Society of Arts, which have been previously alluded to. They also show how highly popular these newly established exhibitions became. The following extract from the preface is, like the above, in Dr. Johnson's grand

manner :—" The public may justly require to be inform'd of the nature and extent of every design for which the favour of the public is openly solicited. The Artists, who were themselves the first projectors of an Exhibition in this nation, and who have now contributed to the following catalogue, think it therefore necessary to explain their purpose, and justify their conduct. An Exhibition of the works of art, being a spectacle new in this kingdom, has raised various opinions and conjectures among those, who are unacquainted with the practice in foreign nations; those, who set out their performances to general view, have been too often consider'd as the rivals of each other, as men actuated if not by avarice, at least by vanity, and contending for superiority of fame tho' not for a pecuniary prize. . . . . . The purposes of this exhibition is not to enrich the Artists, but to advance Art ; the eminent are not flatter'd with preference, nor the obscure insulted with contempt ; whoever hopes to deserve public favour is here invited to display his merit."

The Exhibition of the Society of Artists of Great Britain for 1761 is styled on the catalogue "the second year," but no explanation of the secession from the Exhibition of the Society of Arts is made. This catalogue contains a frontispiece by Hogarth, representing Britannia as watering the roots of the three trees, labelled respectively Painting, Sculpture, and Architecture, from a fountain surmounted by a bust of George III. Hogarth himself exhibited no less than seven pictures, among which were his celebrated "Sigismunda," the "Gate of Calais," "Picquet, or Virtue in Danger," and "The Election." Gainsborough sent a whole length portrait, Reynolds five portraits, and Richard Wilson six landscapes. Although Francis Hayman applied to the Society of Arts for permission to hold a second exhibition in its room, which was granted, he sent to this rival exhibition a picture of "Sir John Falstaff sending Recruits." The receipts from this exhibition were £650. The Society of Artists of Great Britain obtained a Charter and a coat of arms in 1765, and became known as the Incorporated Society of Artists. George Lambert was appointed the first president, Francis Hayman the first vice-president, and F. M. Newton the first secretary. It will be noticed that all these three names are among those of the promoters of an academy in 1753, previously alluded to. Several other names are the same in the two lists, as Charles Grignon, John Gwynn, Samuel Wale, Richard Yeo, &c., so that the promoters who were before their time in 1753, obtained their object in 1765. The Incorporated Society seemed to be on the high road to prosperity, but, in spite of complaints, it did nothing for teaching, and formed no school, so that many of the leading artists became disgusted, and in 1768 the Royal Academy was founded, and from that date the Incorporated Society steadily declined, although, for a time, some of the Royal Acadamicians continued to send to its exhibitions.

With respect to the establishment of the Royal Academy, which eventually caused the death of both the Incorporated Society and the Free Society, it may be mentioned that in the exhibition of the Free Society in 1772 Chevalier Manini showed a picture of the establishment of the Academy of Arts, which is fully described in the catalogue, and said to be erected by George III., "in imitation of the School of Athens." "On the king's right hand is placed Raphael, and on the left Michael Angelo, who propose the institution of prizes for the encouragement Arts."

The exhibitions of the Incorporated Society continued to be held in Spring-gardens until 1771. In the following year the Society removed to their "new room near Exeter Exchange," which was on the site of what is now the Lyceum Theatre. In 1777 the Society went to Piccadilly, near Air-street; in 1780 to Spring-gardens, and in 1783 to Exeter Exchange again. The end was now not far off, and no exhibition was held between 1783 and 1790. In the latter year the catalogue contains a preface, promising what was to be done in the future, which commences thus:—"After having been withdrawn several years from public notice, the Society of Artists, instituted by Royal Charter, again offer themselves to view, by a renewal of their annual exhibitions. It is, nevertheless, under many disadvantages that they now appear as candidates for public favour. They have suffered much from every kind of opposition : from reports industriously circulated, to the injury of their labours; from pretended friends, as well as from those who were not believed to favour the Society with their good wishes; but the indulgent eye will consider the present as the first effort of a recovery to increasing health and vigour." But nothing came of these promises, and the Incorporated Society died.

The Society of Arts having discontinued its connection with the Exhibitions of Pictures in 1765, did nothing further in this way for some years. They held, however, in 1783, an exhibition of the pictures which James Barry had painted in the Great Room. These pictures, which mark a distinct epoch in the history of English art were commenced in 1777, and completed in October, 1781. A great desire was evinced by the public to see them. The first exhibition was open for two months, and was visited by 6,441 persons; the second exhibition, in 1784, was open for a like period, and was visited by 3,511 persons. A charge of one shilling was made for admission, and the proceeds amounted to £503 12s. which the Society handed over to the artist. The cost of the exhibitions was £174, which was defrayed by the Society. When the Society of Arts was incorporated by Royal Charter in 1847, a series of Art Exhibitions was arranged largely on the initiative of the late Sir Henry Cole. The first exhibition of select specimens of British Manufactures and Decorative Art was opened on March 3rd, 1847, and in 1850 a fine exhibition of ancient and mediæval art

was opened. On January 27, 1847, Mr. Cole read a paper before the Society, "On the Formation of a National Gallery of British Art by Public Voluntary Contributions," in which he proposed "to collect once a year, and exhibit in the Society's Great Room as many as possible of the paintings of some one eminent living artist, and to couple with the collection of pictures an exhibition of all the engravings from them." The reader of the paper added "the principal object, then, of the exhibition is to amass a fund for the purpose of forming a nucleus of a gallery of the best works of British artists, to be thus enabled to give to the artist whose works are exhibited a commission for a picture without dictation as to subject and size—to give him a commission in such a mode and in such terms as shall be calculated to obtain from him a picture which he would feel a pride in showing to his countrymen as his best work; on which he would rest his fame, and which would offer to posterity, as the best specimen of his genius and ability. . . . When this picture is painted it is proposed to present it to the National Gallery." Mr. Cole remarked, that "as the Society took a foremost position when British art made its first steps in the establishment of an academy, so it is a fitting sequence that the Society should now proffer its aid, and become the first agent to gather together, as in a treasury, the fruits of that academy in its years of maturity." In accordance with this proposal, an exhibition of pictures, drawings, sketches, &c., of William Mulready, R.A., was opened in 1848. The number of works exhibited was 214, lent by their possessors, among whom were H.R.H. the Duchess of Gloucester, Mr. John Sheepshanks, Mr. Joseph Gillott, Mr. H. T. Hope, Mr. Thomas Baring, Lord Northwick, Sir Robert Peel, Lord Colborne, &c. Among the pictures exhibited was "Choosing the Wedding Gown," now in the South Kensington Museum, which was chosen this year as the subject for the Photogravure Prize. The monetary result of the exhibition was not sufficient to allow of the purchase of a picture, but three of Mulready's sketches were purchased, and given to the National Gallery, in aid of the formation of a Gallery of British Art.

In the following year, 1849, an exhibition of the pictures and studies of William Etty, R.A., was opened, which contained 138 works, lent by the Royal Scottish Academy, Royal Institution, Manchester, Mr. Thomas Baring, Mr. Jacob Bell, Mr. Bicknall, Mr. Joseph Gillott, Mr. Wynne Ellis, Marquis of Lansdowne, Mr. W. C. Macready, Mr. H. A. J. Munro, Mr. J. Sheepshanks, &c. This public acknowledgment of his genius gave the greatest satisfaction to the painter, and Etty's biographer, the late Alexander Gilchrist, wrote—"The exhibition at once established Etty's fame on a footing it had never before attained, and left his enduring claims no longer doubtful. For mere fame, it did more than twenty years of silent labour had effected, anticipating the slow process of further years, raising him at once to the position to which a wider knowledge of his works, in their scattered condition, would gradually have preferred him."*

It was not until 1855 that another exhibition of an artist's works was arranged. In June of that year a collection of pictures, drawings, &c., of John James Chalon, R.A., with a selection from those of Alfred Edward Chalon, R.A., were shown. The total number of works exhibited was 201. In 1860 the miniatures, drawings, and pictures of Sir William Ross, R.A., to the number of 212, were exhibited by the Society. It is interesting to note that Mulready and Ross had in their youth received premiums from th Society. These exhibitions were highly successful, but the amount received was not great, and Sir Henry Cole's object was not attained; it may be noted however that in the formation of these exhibitions the Society again initiated an interesting movement which has been largely grown of late years. About the time that Sir Henry Cole was endeavouring to start a National Gallery of British Art, Mr. Robert Vernon presented his fine gallery to the nation, and ten years afterwards (1857) Mr. Sheepshanks followed Mr. Vernon's example. It may be mentioned in this connection that when in 1890 Mr. James Orrock read his paper on "The claims of the British School of Painting to a thorough representation in the National Gallery," a fine collection of pictures lent by Mr. Orrock was exhibited in the Society's meeting room; this included examples of G. Barret, David Cox, Copley Fielding, W. Muller, Borrington, Philip, Linnell, Holland, W. De Wint, G. Chambers, Vincent, Morland, and other masters of the English school not adequately represented in the National Gallery.†

Before concluding this article on Art Exhibitions, mention must be made of an "Exhibition of Recent Specimens of Photography," at the Society of Arts, in December, 1852, when 397 subjects were shown. This was the first Photographic Exhibition, and in the following year the Photographic Society (now the Royal Photographic Society) was founded. The Society of Arts took great interest in the early development of photography. In 1847, Claudet's paper, on the "Progress of Photography," was read before the Society, and in 1848 the Isis medal was awarded to T. Ross for his method of preserving Daguerrotypes from the injurious effects of light and air. In 1853, medals were given to G. Edwards for his improved portable photographic camera; to A. Claudet for his essay on the spectroscope and its applications to photography; and to the Rev. W. T. Kingsley, for his discoveries in photography.

RUSSIAN SAMPLE MUSEUMS.

In calling attention to the importance o t junction of the Moscow Kazan railway with t

* Life of Etty, 1855, ii. 276.

† See *Journal*, vol. xxxviii., pp. 383, 38

Penza line by the city of Saratoff, which, by reason of its geographical position, has become the principal commercial centre of the Volga region, the Oural railway administration has signified its intention of establishing in that city a permanent exhibition of patterns and samples of the various products and manufactures of all parts of the Russian Empire. Everything, says the *Journal des Tarifs et Traités de Commerce*, combines to make the place fixed upon for this exhibition as most eligible in every way. The railway company has granted, free of cost, the land for the construction of the museum, and has offered every facility at their stations for the notices and advertisements of the various manufacturers who intend to be represented. On its side the Department of Commerce and Industry has informed the railway company that the Administrative Council of the Volunteer Fleet intends to organise floating exhibitions of samples and of products, imported and exported at the ports at which their vessels touch, and invite the co-operation of the company in this undertaking. The company has taken steps to communicate these facts to the Industrial Museum at Warsaw, as well as to the Societies for the Encouragement of Commerce and Industry of Lodz and Warsaw, particularly drawing their attention to the advantages of the scheme, from the point of view of their trade relations not only with Russia itself, but with the Transcaspian district and Central Asia. It is pointed out that by not being the first to occupy a place that may be usurped by foreign producers, merchants and manufacturers of Warsaw and Lodz expose themselves to a keen competition on the markets of the extreme east—a competition that may prove very disastrous to their interests.

*AUTOMOBILE CARRIAGES.**

The fact that a Bill has recently been introduced in the House of Commons to amend the law with respect to the use of locomotives on highways, is one that no coachmaker can regard with indifference. Its object is to exempt carriages, propelled by other than horse-power, from the regulations of the Locomotives Act in cases where they are not used for traction purposes.

Now, the Locomotives Act was passed mainly with the object of applying to engines used for traction purposes, and it was totally inapplicable to the light horseless carriages which are used in Paris and other parts of France.

By the law of this country, the road engine cannot proceed at a greater speed than four miles per hour in the country, and two miles per hour in the town, and the object of the new Bill is to remove the legal obstacle as to speed, in order that we may try those light self-propelled carriages which are used in France, where they are very correctly called "automobiles." It is not to be believed that our country, which builds locomotives as excellent as any that are made, and which, for a long time, led the world in their production, can any longer refrain from following the lead of its neighbours in experiments which have yielded such valuable results.

We know that steam carriages were used experimentally in this country more than half a century ago. Those of Hancock ran in London; Gurney worked his between London and Bath and elsewhere; and there was a regular service between Glasgow and Paisley, and between Edinburgh and Leith.

The advent of the heavy traction engine, however, prevented any development of this method of locomotion, and it has been left to our neighbours on the other side of the Channel to demonstrate the value of a means of transit which we have neglected. In France, the horseless carriage is permitted a speed of seven miles an hour in the town, and twelve miles in the country. The recent contest between Paris and Bordeaux—in which twenty-seven carriages were engaged—was organised with a view to determine the best kind of motor for such a purpose. With a carriage traversing all kinds of roads, the conditions under which an engine has to work are so varying that the selection of the best motor will be a matter of difficulty; but it will, doubtless, be overcome, and in future years electricity will, in all probability, furnish the power.

The motor of the most successful carriages in the Paris-Bordeaux trials was a petroleum or gasoline engine, in which petroleum is converted into vapour in a heated chamber, from which it passes into the cylinder, is compressed by the piston, and exploded. The chief objection to this form of motor is the vibration caused by it continuing to work whether the carriage is moving or not, and it will require a particularly well-framed body to resist this action. The horseless carriages used in France may be divided into two classes: (1) those in which the motor and carriage are combined in one; and (2) carriages quite distinct from the engine, which runs in front and draws the carriage—generally in the form of a waggonette—behind it, the fore-carriage being taken out and the top-carriage resting on the rear of the engine. The latter form, in my opinion, may be dismissed as unlikely to come into general use. They are unsightly, and must be unsteady and difficult to manage when turning.

The other form, in which the carriage and the motor are combined, is, to my mind, much more workmanlike. Sometimes the motor is in front, and sometimes behind, and the body is made in various forms, a dog-cart with two or four seats, a waggonette with or without a head, a phæton with or without a head, or a small omnibus.

Messrs. Panhard and Levassor make these mechanical carriages to run at a speed of 18 kilometres

* Extracted from the Presidential Address delivered by Mr. John Philipson to the Institute of Carriage Manufacturers, at their annual meeting, 1895.

per hour, which is equal to 11 miles 300 yards. This speed may be exceeded where the state of the roads permits, but it strikes one as ample. The cost of running is surprisingly small, the average being 4 centimes per kilometre for a carriage with two seats, and 5 centimes for one with four seats. The prices range from £168 for a carriage with seats for four. A waggonette omnibus costs £226, and a *vis-à-vis* phæton £216, while the charge for india-rubber tyres is from £16 to £24 additional.

The opinion has recently been expressed in the *Standard*, that if once the trammels are taken off this method of locomotion in the United Kingdom, the development that will follow will assuredly grow to extraordinary proportions, and I am bound to confess that I concur in this view. It may become a reality which we, as coachmakers, will have to face in the near future.

I am not pessimist enough to believe that carriage manufacture, as we now understand it, will suffer to any great extent, or that the production of harness will be less. The number of horses and carriages did not decrease as was predicted when the locomotive displaced the coach.

It is possible to create a demand and a new industry without injuriously affecting those already in existence.

We have seen this in the marvellous extension of cycling. But if horseless carriages come into general use in this country, it will be our duty, as assuredly it will be to our interest, to take care that their manufacture, in so far as concerns everything but the motor, is the work of the carriage manufacturer.

THE PUMICE-STONE INDUSTRY OF THE LIPARI ISLANDS.

So extensive are the deposits of pumice in the Island of Lipari, that, according to a recent report of Mr. Norman Douglass, the supply is practically inexhaustible. It is said that good pumice is not so abundantly found as formerly, but this impression may be attributed to the fact that customers have, of recent years, become more fastidious, and not so easily satisfied with bad stone. That washed up by the sea is hardly ever collected now-a-days. Pumice itself is a trachytic lava, rendered light and scoriaceous by the escape of gases, and every gradation can be traced from this condition to the heavy vitreous matter of similar composition, known as obsidian. Good pumice contains 74 per cent. of silica, 12 per cent. of alumina, 5 per cent. of potash, 5 per cent. of soda, 2 per cent. of oxide of iron, and 2 per cent. of water, lime, &c. Most of the volcanoes of Lipari have ejected pumaceous rocks at some period or other, but the best stone of all is the product of one mountain, Monte Chirica, with its accessory craters, Monte Pelato and Forgia Vecchia. The district containing the deposit lies in the north-east of the island, and covers an area of about three square miles. The mineral is excavated in various parts of it; in the plateau of Castagna, near the sea shore of Acqua Calda, and at one or two isolated points. To this end, caves or burrows are dug into the layers of denuded lapilli or ashes that have gradually covered the pumice. They occasionally strike the mineral near the surface, at other times a thick mantle of white substance must first be pierced. Digging in such circumstances affords no difficulties. These caves are lighted at intervals by small terra cotta lamps of antique form, and are so narrow that two men can barely pass. The deficiency of air is soon felt. Sometimes when a stratum of pumice has been reached, radiating galleries are constructed to gain a larger supply of pumice out of the soft material in which it lies imbedded. Some caves ascend, others descend. It is often a matter of speculation how soon pumice will be reached, so that many tunnels are abandoned, while others are worked for long periods. The output may be large one day, and almost exhausted the next, or the quality of the stone may change. It has been observed that certain localities produce certain qualities; thus some of the best pumice comes from Acqua Calda, and Monte Pelato; an inferior quality known as *alessandrina* is found at Castagna. The number of caves actually in working has been estimated at 250, but this gives no idea of the number of workmen, as some caves can accommodate only three or four, others as many as fifteen men. The number of cave workmen also fluctuate, according to their personal requirements and the season of the year, while the number of those employed in the workshops of the merchants at Lipari and Cannets depends upon the needs of the latter. It has been calculated that there are about 1,000 hands employed altogether, 600 of whom are engaged in extracting the mineral. Pumice is brought to the surface of the earth in large blocks or in baskets, and is carried thus either direct to the village of Canneto, or to the nearest sea shore, to be taken there in boats. About one-fourth subsequently reaches Lipari by sea, to be manipulated there. It is generally stored in the sheds of the merchants, and unless these are in a hurry to dispose of their stock, it is allowed a month to get thoroughly dry; this reduces the weight, and shows off the quality. Large blocks, weighing a stone and upwards, are allowed to crumble, according to their cleavage, into so-called *lisconi*, and all the pumice is then sorted, according to its size, into *grosse*, *correnti*, and *pezzame*, that is, into large, medium, and small pieces. The quality is primarily a matter of texture. As pumice is used for polishing purposes in various trades, an essential condition is a certain homogeneity of structure and freedom from included crystals, &c. The stone must be neither too brittle nor too hard, and it is in these respects that the Lipari pumice surpasses that of other volcanic regions. After it has been divided, according to its size, the large stones (*grosse*) are again sorted

into three superior qualities, called *fiore*, *quasi fiore*, and *mordente*. These are never filed. After they have been selected, the remainder of the *grosse* are filed by hand, in order to remove asperities of surface, and to test whether the stone is not too friable for use. They are then re-classified into first, second, and third pick (*bianche*, *dubbisoe*, and *neve*). Large pieces of inferior pumice, known as *rotonde*, are never trimmed. Besides this, there is an entirely different variety, so called *alessandrina*, which is cut with hatches into brick-shaped pieces, and used for smoothing oilcloth, and a heavy dark stone, *bastardone* (always trimmed), as well as many less important varieties. The *correnti*—commercially termed "sorts"—contain all varieties, and are generally exported as they are; the *pezzame* is usually, but not always, ground to a powder of more than ten different degress of fineness, according to the work for which it is required. There are between twenty and thirty merchants engaged in the pumice-stone trade in the island of Lipari, the majority of whom live in the village of Canneto, and are of Italian nationality. The better kinds of pumice are packed singly in paper and in barrels of different sizes, made at Lipari. Crates are also used, and the *pezzame* and powder are usually exported in second-hand Indian grain sacks. Formerly, all the Lipari stone found its way to Leghorn, where the merchants sorted and packed it for shipment, securing large profits. There is still a considerable quantity of *pezzame* ground there, as Lipari possesses only three mills; but the export has been gradually discontinued, and the dealers of the island now communicate direct with the consumers. The work in the *barache*, or workshops of the merehants—filing, &c.—is mostly done by women, who receive daily wages of about 80 centimes. As regards the destination of pumice, the French market demands the best stone, and differs from the British in not accepting filed material. In point of quantity imported, England probably stands first, then France and America, with Austria, Germany, and Belgium following. Large lumps, known as *testoni*, are sent to Trieste, to be ground to powder there. Almost all the *alessandrina* finds its way to England and the United States. A good deal of inferior pumice is also sent to St. Petersburg and Odessa.

VENETIAN MOSAICS.

Attention is called by the British Vice-Consul at Venice, in his last report, to the revival in that city of the mosaic art, chiefly for internal and external artistic decoration of public and private dwellings. It is well known that a mosaic is a work, formed by the use of "tesseræ," or small cubes of enamel, marble, or other material, and of a gold or silver leaf between two films of the purest glass of various colours, which are skilfully fixed on cement, so as to produce the effect of a picture. The composition of human figures, in different attitudes, animals, draperies, or other objects requiring a skilful delineation, are entrusted to the best workmen. The family of the Zuccati worked in the 16th and the beginning of the 17th century from cartoons by Titian, Tintoretto, and other famous painters of that epoch. The best specimens of the mosaics produced by them can be seen in the Cathedral of St. Mark and on the vault of the sacristy. Working in mosaic is now carried on in Venice on a large scale, and with great success. The splendid mosaics which are made there continue to be in great demand in the artistic markets of the world, for the skilful manner in which the tesseræ are arranged, for their extreme beauty and delicacy of colour, the rich harmony of effect, and from their being nearly indestructible. The manner in which mosaics are now made, for decorative purposes, is quite different from the elaborate system used by the ancients, which consisted in fixing the tesseræ, one by one, on the cement previously applied, on the wall. The modern method of the Venetian school consists in executing the mosaic in the workshop, by having the tesseræ fixed with common paste on the section of the cartoon assigned to each workman. When all the parts of the mosaic are complete, they are put together on the floor, or on a special wooden frame. The mosaic, which is then a perfect representation of the original cartoon, is again divided into sections on the reverse side, marked with a progressive number, and carefully packed, to be sent off to the place for which it is intended. The surface of the wall where the mosaic is to be fixed is then covered with cement, into which the sections of the mosaic are uniformly pressed according to their numbers and the key plan supplied to the fixers. When the cement has hardened the paper on which the tesseræ have been pasted is gently taken off, and the faithful copy of the original cartoon is again exhibited on the right side. The British Vice-Consul says that he has previously called attention to two magnificent mosaics executed in Venice by artists in the employ of the Venice and Murano Company, representing the landing of Columbus in America and his return to Spain, and an immense portrait of the great discoverer presented by Venice to Genoa. These most important works have been executed and fixed by the same company for the American Church in Rome, for the Royal Opera House in Munich, and for the Cathedral of Bremen. The two arches of the American Church in the lowest recess of the apsis were covered with two splendid mosaics made from the cartoons of Sir Edward Burne Jones, representing the "Tree of Life" and the "Annunciation of the Virgin." These two panels, measuring some three hundred square feet each besides other ornamentations introduced between the arches and in the pendentives and lower parts of the semi-dome, form the completion of the mosaic that covers the curve of the apsis, and for which the famous artist above-mentioned designed, four years ago, the majestic figure of

the enthroned Saviour surrounded in his glory by a halo of cherubs and angels, and having at his sides five archangels holding their emblems and coming out of the five gates of the Holy City, the sixth gate remaining empty to record the fallen angel. The mosaics for the Royal Opera House at Munich were ordered to substitute, on the two great tympanums of the façade, the famous frescoes by Schwanthaler, that were perishing through the effects of the atmosphere, and were executed from the cartoons of an eminent painter, who, in reproducing the original frescoes, introduced in his sketch some important modifications. They are in modern pictorial style, and represent the mythological figures of Parnassus. The upper tympanum is crowned by a colossal pegasus of great effect, and the lower one shows, arranged in processional order, Apollo and the Muses. No one, looking at these mosaics from below, could, it is said, believe that they are not a fresco painting. The two works for Rome and Munich, referred to above, although differing from one another in style, contrast even more strongly with the mosaics executed for the Cathedral of Bremen. The two large panels are placed over the two principal gates, and are in the "Cinquecento," or, more exactly, in the "Bramantesque" style. They represent the Crucifixion and the Saviour sinking under the weight of the Cross. With their broad treatment of the various groups of figures and of the draperies, they furnish one of the finest examples of enamel pictorial mosaic work, both as regards execution, beauty, and richness of colour.

LAND TENURE IN ANGORA.

Farms, in the proper acceptation of the word, cannot be said to exist in the vilayet of Angora, consequently there are no tenants in the sense implied by that term in Europe. Except in the immediate vicinity of towns, the land is owned and cultivated by peasants belonging to the neighbouring villages. Large sheep and goat owners possess more or less extensive tracts of land with a few cottages on them, but beyond the pasturing of the animals, no serious agricultural or dairy operations are engaged in by them. The plots owned, or rather cultivated, by the peasant farmers vary from 10 to 100 acres. Consul Cumberbatch says that, apart from irrigated land, which is generally reserved for barley in Angora, and is always sought for, the peasant does not care much whether he owns land or not. Arable land is more than plentiful, and close at hand. Anyone is free to cultivate Crown land, and becomes the legal owner thereof, after ten consecutive years of cultivation, the calculation being that in ten years the cultivator pays the full value in tithes. On the other hand, land left uncultivated or unused for pasturing or other purposes for ten years, reverts to the Crown. The peasant and his family depend entirely on the yield of their plot, supplemented by the produce of the one or more cows and of the sheep and goats, which are either his own or are supplied by his "partner." A system of partnership is commonly resorted to, especially if it offers the peasant a chance of securing a little hard cash. He never resists the temptation of a loan, no matter what interest is demanded. Under the contract of partnership, the outside partner, who is generally a Greek or Armenian of the nearest town, undertakes to furnish—that is to say, sell on credit—a pair of oxen, valued at about £7 10s., and sometimes provisions for maintaining the peasant and his family till harvest time, namely, 15 to 30 bushels of wheat. He also advances £2 to £3 in cash and supplies the necessary seed, at the rate of 20 to 30 bushels per pair of oxen. The peasant, on his part, contributes land, labour, and implements. In settling accounts at harvest time, the produce, after payment of tithes, is equally divided. The seed supplied "dies," that is to say, is not returned to the "outside" partner, but the value of the other items is deducted from the cultivator's share. If the oxen lent for ploughing are not returned, their estimated value has to be given. Taking into consideration the periodical droughts which occur in the districts of Angora, and the primitive methods of cultivation in vogue, the average result of a wheat crop can be estimated at fivefold. The demand for "outside" partnerships is in proportion to the success or failure of the preceding year's crops. After an abundant harvest there is little or no demand for partners, whilst in a year succeeding a bad season, nearly every peasant farmer finds himself in absolute need of one or more partners. The poorer class of agriculturists work their 10 or 20 acres with one pair of oxen, which are sometimes supplied by their outside partner as stated above. Those that are better off, and have from 60 to 100 acres to cultivate, possess four to five pairs of oxen and as many primitive ploughs. One pair of oxen are calculated to plough ten acres per annum. All the members of the family assist, whilst several farm hands, who receive about £4 10s. per annum and their food, are employed. Day labourers receive 6d. to 10d. a day without food, and reapers, during harvest time, 1s. 4d. to 1s. 8d. per day and their food.

INDUSTRIES OF THE GOLD COAST.

Considerable attention is now being paid to the plantations of coffee and cocoa at the Gold Coast, in the cultivation of which, but more especially the former, the natives appear to have become interested. Along the road leading from the botanical station through the country of Akwapim to the interior, are large numbers of small clearings in which coffee plants chiefly obtained by purchase from the botanical station, are to be seen in the most flourishing condition. The Liberian coffee plant appears to thrive best, but there are large quantities also of the Arabian

coffee plant, the berry of which, however, is small and, apparently, deteriorated. The Colonial Secretary, at Accra, says in his last report that it will probably be necessary for the Government at no distant date, if the coffee industry is to be fostered, to instruct the native cultivators in the proper way of preparing the berry for export. At present the most primitive methods are employed. The berries are scraped, by hand, with a round stone worked in the hollow of a large stone, and after this process they are washed and dried in the sun. It is obvious that a large crop could not be so dealt with, and that the employment of machinery in the near future is imperative. The initiative will have to be taken by the Government because of the general ignorance on the part of the natives of all machinery even of the simplest character, and because no single native cultivator possesses sufficient capital, enterprise, or experience to take the matter in hand. The only manufactures carried on by the natives are manufactures which the necessaries of life have driven them to undertake. The most important is the manufacture of earthenware pots of various sizes, ranging from a capacity of four to twelve gallons, for the purpose of carrying and storing water for drinking and household purposes. These pots are made principally in the country of Shai, which lies behind the trade port of Pram Pram, where the clay is admirably adapted for the purpose. The pots, which in shape are exactly similar to the English glass bowls used by dealers in gold fish, are moulded by hand and shaped by eye. They are baked in the first instance, and are then subjected to a slow wood fire for three days, when if the latter and important process has been properly carried out the pots come out black and hard. Before the pots have cooled each is polished by hand, and for this purpose the covering of the palm kernel is used. This thready covering is heated over the fire in which the pots have been baked, and is then taken in the palm of the hand and rubbed over the outside of the pots. It acts as a varnish and imparts to the pots a brilliancy which may best be compared to a well polished fire-grate. The pots are then packed longitudinally in crates made especially for the purpose and adapted to conveyance as a head load, and are carried to the markets where there is a ready sale for them. The market prices for these pots ranges between one shilling and sixpence and three shillings and sixpence each, according to size. The drying of fish is also a staple industry of the country. All the large sized sea fish caught by the coast fishermen are split open and cleaned. They are then closed and kept in salt water for three days until they begin to get putrid—which condition affords the flavour dear to the natives—when they are again opened and covered with salt, to prevent the presence of flies and other insects. They are then sun-dried, and become ready for food. The herring, which is a common sea fish on the West Coast of Africa, is treated differently. It is not subjected to the cleaning process, as in the case of the bigger fish, but is quickly roasted in clay-made ovens, and then smoked over an open fire, which is arranged on a shallow pit, about one foot in depth. Fish are also salted into barrels. These specially prepared fish are carried to the markets throughout the country, and form a recognised article of native diet. Their presence is soon made apparent, especially in the case of the sun-dried fish, by the putrid smell which arises from them, and which, as the Colonial Secretary points out, appears to be one of the principal attractions to the unsophisticated native. Baskets and crates, adapted for carrying goods on the head, are extensively made in every part of the colony, and on the coast all the fishermen make their own nets often from yarn which has been manufactured out of native-grown fibre and cotton. In many of the villages of Akwapim and Krobo there are blacksmiths' forges, where rough ironwork is turned out, such as door hinges, door handles, bolts, window fasteners, &c. Mining and working for gold is extensively carried on, especially in Wassaw and Akim. The country is rich in gold, it is to be found everywhere in large or small quantities, and there is no native family in the country without its family gold ornaments of the purest gold and often of artistic workmanship. The insignia of the Court officials of a native king are almost invariably covered with beaten gold, and gold dust among the natives is a common medium of exchange. The natives mine for gold in a very primitive manner; they do not use mercury, and their returns are much smaller than they would be if more perfected systems were adopted. A native miner has but few implements—a long-bladed spud or dagger, a wooden bucket for bailing out the water or hoisting out the stuff, and a bowl for washing or "vanning" make up the list. He rarely makes his shaft more than three feet in diameter. Planting one end of his digger into a recess in the shaft he places the other end diagonally against the opposite side of the shaft, and supporting himself by it his foot is placed in another of the recesses. He then lengthens out his body and fixes his back firmly against the side of the shaft. Thus supported he removes the digger, plants it in another recess below the first, and by repeating the operation gets to the bottom of the shaft. For many years past gold mining on an extensive scale has been carried on by several English mining companies in Wassaw.

STOCK BREEDING IN ARGENTINA.

Stock breeding, according to H.M. Secretary of Legation at Buenos Ayres, must be regarded as the most important industry in the Argentine Republic. The live stock in the Republic may be calculated at 25,000,000 cattle, 80,000,000 sheep, and 5,000,000 horses. The pastoral industry is chiefly centered in the province of Buenos Ayres, and, in a lesser degree,

n those of Entre Rios, Santa Fé, and Cordova. Next in importance are the territories of the Central Pampa, the valley of the Rio Negro, and, finally, some portions of the Patagonian coast, notably at Rio Gallegos, which owes its development chiefly to settlers from the Falkland Islands. The system of stock-raising in this country is not in all respects similar to that followed in Australia and New Zealand. The breeder in the Argentine runs both cattle and sheep on the same pastures, finding that owing to the variety and nature of the grasses the presence of both are necessary to the maintenance of the best feeding herbage. Land is the property of the private individual. Grazing rights do not exist except in some of the most remote of the national territories, and even there, as soon as the tide of emigration reaches them, they are bought in freehold by the stock breeder. Stock is principally bred by the landed proprietor, or *estanciero*, who exploits his land by breeding horses, cattle, and sheep on it. An estancia varies in area from 3,000 to 6,000 acres. Another and less important class is formed by the renter of land, who pays from 8 to 10 per cent. rental on the value of the land. A large number of these renters occupy a run sufficient for one flock of sheep, in area from 600 to 900 acres. The combination of agriculture with stock-breeding is but little practised, with one notable exception, the great lucerne lands of Santa Fé. Finally, there is the grazier, who buys cattle and fattens them for market upon land kept more or less free of breeding stock. He is termed an *invernador*, *i.e.*, one who winters stock. He also generally rents the land he exploits, and his district is confined to the lands within about 200 miles of the city of Buenos Ayres. It is the practice with some *estancieros* to reserve certain paddocks for the purpose of buying and fattening stock. The *invernador* is practically the middle man between the producer and the consumer. Horse-breeding has not been attended with great success. The ordinary horse of the country, the criollo, is a hardy animal, useful for the work on an estancia, but little value elsewhere. Some attempts have been made to find a market for him in England and in France, but he is too small for carriages, omnibuses, or tramway cars, and as a remount for the troops he has also been found deficient. The value of the criollo horses is from 30s. to £2 sterling. The criollo stock has been improved by the introduction of Clydesdale and other heavy draught breeds, to produce a useful animal for the agricultural districts and for export. Carriage horses are bred for export, but the market is limited to the city of Buenos Ayres, the irregular demand of the agriculturist, and the Republic of Brazil. The original cattle of the country were small, long-horned, thick-hided, slow-growing beasts, of every conceivable colour; but, for the last twenty years, a considerable reformation has taken place, and there are few herds left now that do not own to some degree of English blood. The markets for the cattle industry are the following:—Local consumption and Chili, "Saladeros," Brazil, and Europe. For local consumption and Chili, the stock is generally of an inferior quality, and both steers and cows are supplied. By far the greatest number of steers go to the Saladeros. This industry is of most ancient origin, and, until within very recent years, was the only outlet of the surplus cattle stock. The steers are slaughtered, their hides removed, and the meat taken from the bones in great pieces. These pieces, termed *mantas*, are salted and sun-dried, or jerked. The hides are steeped in salt, and exported in that state to Europe. The meat is exported to Brazil and the West Indies. The bones and refuse are boiled down and the grease extracted, and finally exported to Europe for the purposes of manure. Owing to the falling off in the Brazilian trade, the protective policy of Spain as regards the West Indies, and also to quarantine, this trade has declined within the last year, but as soon as the difficulties, which are only temporary, are removed, it is expected to continue as extensively as formerly. In relation to the Saladero business, there is, moreover, the collateral one of tongue preparing and meat extract, which has grown up beside it, and of which Liebig's great establishment is the most notable example. The Argentine Republic has not yet succeeded in exporting chilled beef to Europe. Finally there is the export of live stock to Brazil and Europe, an industry which has only sprung up within the past five years, and in that period has already developed in a marvellous manner. The steer exported to Brazil is that which is considered too good to sell to the Saladero, and not good enough for Europe. For the export of live stock to Europe, a first-class cross-breed steer, three years and upwards, is demanded of not less than 1,320 lbs. live weight, and the price paid locally by the exporter is from £6 to £8 per head. The sheep stock in the Argentine has merited greater attention at the hands of the breeder than either cattle or horses. Up to 1880, the sheep were almost entirely of a merino strain, but about that period the industry of freezing mutton was first established, and the breeders finding the carcase of the merino of little value for export, turned their attention to English breeds, and particularly to the Lincoln sheep. Argentine wool is chiefly consumed in France and Germany. It is sold locally in the Buenos Ayres wool markets. It is not washed on the sheep's back, but is all sold dirty and in the grease. The general fall in wool prices has been felt most acutely in the country, where the deficiencies in careful breeding, and the prevalence of the scab disease, occasion the production of inferior classes of wool. As regards Argentine mutton, the markets for its consumption are local, meat-freezing establishments, and the export of live wethers to Europe. The local consumption has been estimated at 5,600 head per annum. The meat-freezing trade, instituted in 1882, has been for the past decade the most im-

portant outlet for the Argentine wether. There are at present five of these establishments capable of exporting between them all 3,000,000 frozen carcases per annum. These are private enterprises, and not supported by Government. It is the opinion of Mr. Herbert Gibson, who has been the owner of one of the largest sheep farms in the country, and the author of a work on sheep farming, "that the Argentine Republic can afford to undersell the whole world's meat trade, and remain sole caterer."

ICE SAWS FOR OPENING NAVIGATION.

The invention of an ice-sawing apparatus, by which bodies of fresh water may, in winter, be kept open for navigation, is of considerable importance. The United States Consul at Ghent says that such a machine has been satisfactorily tested on the River Scheldt at Antwerp. M. Caméré, the inventor, had already foretold its practicability at the Congress of Navigation, held at the Hague last summer. His apparatus consists of a strongly-built boat with rounded sides, carrying a small portable steam-engine. At the bow a movable framework, which may be raised or lowered at will, carries the axes of two circular saws; these latter are operated by power from the portable engine. The boat itself is moved by means of a rope run over a windlass, the loose end of the rope being attached to an anchor fixed in the ice at a distance in front of the boat, and in the direction to be taken. The windlass upon the boat is operated by hand-power, and the speed attained depends upon the rapidity with which it is worked. The framework containing the saws is placed at a suitable height, according to the thickness of the ice, and the same are set in motion. Being separated from each other at a distance of about five yards, they cut out a band of ice, which the boat breaks into fragments by its forward movement. By reason of its form, it forces these fragments to scatter before it—that is to say, to disappear on the right and on the left under the ice remaining in place. The channel thus traced remains free. Through ice two inches thick this machine, says Consul Morris, forced a passage of twenty feet in length per minute. In eight inch ice the advance was only about one-third of a mile per day. The trials last winter were considered satisfactory, but the machine is susceptible of improvement, such as propulsion by steam-power, and the addition of other apparatus forward for the crushing and removal of the ice in its path.

THE IVORY TRADE OF ANTWERP.

The *Matin* of Antwerp recently published an article upon the Congo, in which considerable space was devoted to a statement of the ivory trade. The exportation of ivory from the Congo has, it is stated, never been pushed. The native tribes have a habit of hoarding the teeth. Many have been preserved for centuries, hidden either in the river beds or in the soil. Antwerp has become the principal market for ivory, as the statistical returns show. In 189[illegible] the quantity imported amounted to 583,117 lbs., and during the period comprised between the years 1888 and 1894 the total quantity of ivory imported was 1,755,972 lbs. Prior to 1890, ivory markets were held annually at Antwerp; since that date, however, they have been held every three months. At the first sale of 1895, which took place on the 29th and 30th January last, the amount of ivory offered for sale was 135,142 lbs., as compared with 82,673 lbs. for the corresponding period of 1894. Merchants now come from Germany, France, and England. As the ivory is sold by auction, and goes to the highest bidder, those who formerly fed the markets of London, Liverpool, and Havre now give the preference to Antwerp. The Niger Company now sends its goods to this market. The total quantities of ivory from the West Coast of Africa offered for sale at the principal markets in 1893, according to Consul Morris of Ghent, were—Liverpool 156,527 lbs., London 243,608 lbs., Antwerp 487,217 lbs. In 1894, the figures were — Liverpool 131,174 lbs., London 153,220 lbs., and Antwerp 410,066 lbs. As may be observed, the quantity sold in Antwerp in 1894 was about 77,000 lbs. less than in 1893. This fact was due to a decreased importation made under agreement by the principal importers. Owing to the conquest of Central Africa by Belgian authority, a considerable quantity of soft ivory is finding a sale at Antwerp. Formerly it went exclusively to London by way of Zanzibar. There appears to be no reason to fear the exhaustion of the ivory supply. As above mentioned, the yield of centuries is still in the hands of natives who know where it is hidden. It is estimated that there are also about 80,000 elephants still living.

General Notes.

Embroidering Machines in Switzerland.—The *Moniteur Officiel du Commerce* has lately given some statistics drawn up by the Economic Department of Saint Gall, of the number of embroidery machines in use in Switzerland. From these statistics it would appear that in the present year there are 16,016 machines in use in that country (as against 18,405 in 1890), and 1,188 not in actual use. Of the total at present in use, the Canton of Saint Gall has 9,282 (10,630 in 1890); Appenzell, 2,476 (2,744 in 1890); and Thurgovia, 3,078 (3,587 in 1890).

Journal of the Society of Arts.

No. 2,234. Vol. XLIII.

FRIDAY, SEPTEMBER 13, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

JAPANESE ART INDUSTRIES.

By Ernest Hart, D.C.L.

Lecture I.—Delivered May 27, 1895.

Keramics, Bronzes, Lacquers.

The chief object that I have in view in these lectures is not so much to give the history of the arts of Japan, as to compare the earlier arts of Japan with the present progress of the country in industrial art. In the lectures which I had the honour of giving here some ten years ago, at the time when the history of Japanese art and the nomenclature of art objects, periods, and artists were very little known or observed, I had the opportunity of classifying the historic arts of Japan, and of furnishing—for the first time in this country—a glossary of the names, dates, and periods of the ancient Japanese artists. I derived great assistance from a gentleman now present, the President of the Japan Society, Mr. William Anderson. It has always been a satisfaction to me, and it may be gratifying to the Society of Arts, to know that from the date of those lectures began a new era in the study of Japanese art in this country. At that time, you may remember, the collections were not very numerous, and the collectors, including those who had the most distinguished and remarkable collections of Japanese art objects, took no note of the artists who produced them, or of the periods to which they belonged. Even at our great national museums there was—with the exception of the keramic collection at the British Museum, classified by Mr. (now Sir Wollaston) Franks—no attempt made to identify the artists who had produced these art objects, or to determine the periods to which they belong. These lectures attracted also the attention and approval of the Japanese authorities. They were in part republished in the official journal; and a popular Japanese translation of them, which has been widely circulated, is on the table. I am glad to say now that almost everyone in this country who possesses Japanese objects has become thoroughly imbued with the sense of the necessity of studying Japanese art in the same way as people had previously studied European art; that is to say, by distinguishing between originals and copies, between schools and periods, and in making themselves familiar with the names of artists and the schools, with the periods and styles which the art works represented. I remember perfectly well formerly remonstrating with one of the directors of the South Kensington Museum that the collection of Japanese objects of art there was not classified or representative of the great historic schools. He said in reply, "What does it matter? One Japanese object is as good as another. I would just as soon have a copy as an original; it does not matter to us whether it is new or old; there is no reason why we should classify them." That is not the way we speak of European art. No curator of a museum would say it was a matter of indifference to him if a Raphael was a copy or an original, or even of a Sevres cup or wood carving. Such ignorance is now inexcusable, as there is ample opportunity for studying Japanese art in the same way as we study European art.

On the other hand, there is now a tendency in some places to excess in what we may call the archæological direction. There is, at the present moment, a worship of mere names; thus, for example, anything in the way of colour prints which is signed Outamaro at once becomes an object of adoration, because Outamaro has been distinguished as the great print maker of Japan, although there are half a dozen artists in chromo-xylography at least as good as he. The danger in this worship of mere names is that those who are new to the study of Japanese art may be deluded into loading their collections with comparatively worthless products which bear great names. Collectors in Japanese art, as in every other art, must not be led merely by names and signatures. We, as well as the Parisians, have become so imbued with the idea that only the ancient art of Japan is of any value; we have be-

come so determined to buy only objects bearing certain well-known names, that the market is being flooded with more or less clever imitations of ancient art. Japanese art should be judged like European, by its intrinsic merits, and while the work of special masters should be valued, the style, the touch, the individual genius of the master should be as recognisable by connoisseurs as his signature, so that if the latter is present, and the former wanting, the piece may be rejected as a forgery.

In certain departments the Japanese are now as highly capable of great artistic productions as they were at any period in their history. It depends very much upon the appreciation of the European public whether art industries shall progress in Japan, or whether they shall retrograde. In some of the departments of art Japan is standing at the parting of the ways. In some arts the ancient traditions remain, but no proper impulse is given to the Japanese artists as to the path and form in which their efforts might be directed. They are not told what it is we foreigners want. I am in great hopes that, with the opening up of the country by the new treaty, European agents in Japan will enter more thoroughly into the work of the Japanese art factories, and explain to the artists what are the kind of objects to which their industrial art may be applied most advantageously.

To speak first of keramics, at the present moment there are potters of as distinguished and remarkable ability as ever there were in the history of Japan, but all their best products are either kept in the country, or go to America. Looking to the exports, I find that Japan exports one and a half millions of yens worth of porcelain and pottery. The great bulk of this goes to the United States, the next largest amount to England, and the rest to China, Hong Kong, France, and Germany. We find that the present size of the porcelain manufactories are much the same as they were three hundred years ago. The exports consist chiefly of Imari wares, Seto wares, Iichi wares, the Soma wares of Kishima, Kutani wares, and Banko, Awata, and Kiyamidzu ware. These are all the great old names, but I am bound to say that on recently examining, as I did for the purpose of these lectures, the warehouses of the chief importers, I was able to find but very few good pieces. The demand in England is unfortunately for the commonest and cheapest kind of Japanese keramics, for basins, flower vases, cups, plates, &c., with the most imperfect and degraded decoration.

On the other hand, Japan has at the present moment keramic artists, Makuzu, Seifu, Tanzan, Meizan, who produce work which has never been surpassed by the ancient Chinese potters.

I will proceed now to speak more definitely on the great potteries of Japan and their work. I visited most of these during my tour through Japan, with the advantage of an efficient guide, furnished by the Government. But the information which I then acquired is most opportunely supplemented by an excellent report, recently published, by Captain Brinkley, the great art authority of Tokio, in his account of the exhibition at Kyoto.

The history of Kyoto keramics, he points out, is the history of individual artists rather than of special manufactures. Speaking broadly, however, four different varieties of ware are usually distinguished. They are *Raku-yaki*, *Awata-yaki*, *Iwakura-yaki*, and *Kiyomizu-yaki*. *Raku-yaki* is essentially the domestic faience of Japan, for, being entirely hand-made and fired at a low temperature, its manufacture offers few difficulties, and has consequently been carried on by amateurs in their own homes at various places throughout the country. The *Raku-yaki* of Kyoto is the parent of all the rest. It was first produced by a Korean who emigrated to Japan in the early part of the 16th century. But the term *Raku-yaki* did not come into use until the close of the century when Chojiro (artistic name, Choryu) received from Hideyoshi (the Taiko) a seal bearing the ideograph *raku*, with which he thenceforth stamped his productions. Thirteen generations of the same family carried on the work, each using a stamp with the same ideograph, its caligraphy, however, differing sufficiently to be identified by connoisseurs. The faïence is thick and clumsy, having soft brittle and very light *pâte*. The staple type has black glaze showing little lustre, and in choice varieties this is curiously speckled and pitted with red. Salmon-coloured, red, yellow, and white glazes are also found, und in late specimens gilding was added. The *raku* faïence owed much of its popularity to the patronage of the "tea clubs." The nature of its paste and glaze adapted it for the infusion of powdered tea, and its homely character suited the austere canons of the "tea ceremonies."

Awaka-yaki is the best known among the keramic productions of Kyoto. There is evidence to show that the art of decoration with

enamels over the glaze reached Kyoto from Hizen in the 17th century. Just at that time there flourished in the Western capital a potter of remarkable ability, called Nomura Seisuke. He immediately utilised the new method, and produced many beautiful examples of jewelled faïence, having close hard *pâte*, yellowish white or brownish white glaze covered with a network of fine crackle, and sparse decoration in pure full-bodied colours, red, green, gold, and silver. He worked chiefly at Awata, and thus brought that factory into prominence. Nomura Seisuke, or Ninsei, as he is commonly called, was one of Japan's greatest ceramists. Genuine examples of his faïence have always been highly prized, and numerous imitations were subsequently produced, all stamped with the ideographs *Ninsei*. After Ninsei's time the most renowned ceramists of the Awata factories were Kenzan (1689-1740); Ebisei, a contemporary of Kenzan; Dohachi (1751-1763), who subsequently moved to Kiyomisu-zaka, the faïence of which constitutes the Kiyomizu-yaki mentioned above; Kinkozan (1775-1860); Hozan (1610-1721); Taizan (1760-1880); Bizen (1810-1838); and Tanzan who is now living. It must be noted that several of these names, as Kenzan, Dohachi, Kinkozan, Hozan and Taizan, were not limited to one artist. They are family names, and though the dates given indicate the eras of the most noted ceramists in each family, amateurs must not draw any chronological conclusion from the mere fact that a specimen bears such and such a name. The origin of the *Iwakura-yaki* is somewhat obscure, and its history, at an early date, becomes confused with that of the *Awata-yaki*, from which, indeed, it does not materially differ. To separate the two and describe their slight distinctions would carry us beyond the limits of the space at our disposal. In the term *Kiyomizu-yaki* may be included roughly all the faïence of Kyoto, with the exception of the three varieties described above. The distinction between Kiyomizu, Awata, and Iwakura is primarily local. They are parts of the same city, and if their names have been used to designate particular classes of pottery it is not because the technical or decorative features of each class distinguish it from the other two, but chiefly for the purpose of identifying the place of production. On the slopes called Kiyomizu-zaka and Gojo-zaka lived a number of ceramists, all following virtually the same models with variations due to individual genius. The principal Kiyomizu artists were—Ebisei, who moved from Awata to Gojozaka in 1688; Eizen and Rokubei, pupils of Ebisei; Mokubei, also a pupil of Eizen, but more celebrated than his master; Shuhei (1790-1810); Kentei (1782-1820), and Zengoro Hozen, generally known as Eiraku (1790-1850). Eizen was the first to manufacture porcelain (as distinguished from faïence) in Kyoto, and this branch of the art was carried to a high standard of excellence by Eiraku, whose specialty was a rich coral-red glaze with finely executed decoration in gold. The latter ceramist also excelled in the production of purple, green, and yellow glazes, which he combined with admirable skill and taste. Some choice ware of the latter type was manufactured by him in Kishu, by order of the feudal chief of that province. It is known as *Kairaku-yen-yaki*, or "ware of the Kiraku Park."

Seifu.

Undoubtedly the first place among the modern potters of Kyoto belongs to Seifu Yohei. There is scarcely any variety of porcelain or faïence that this master cannot produce with skill at least equal to that of any of his predecessors. Many of the *chefs d'ouvre* of the celebrated Chinese epochs have, it is true, never been attempted by him, but in many others he has achieved marked success. Thus, his blues, *sous couverte*; his *céladons*, monochromatic, or with lace decoration; his yellows, with reserved designs in blue; his coral-red monochromes, his ivory-white, and jewelled wares, all belong to the very highest category of keramic skill. Possibly the most remarkable among them is ivory white. He had been working at this for many years before he developed the beautiful ware of which, doubtless, some grand specimens will be shown at the approaching exhibition. Seifu is his own designer; he works on a comparatively small scale.

Kinzkzan.

Kinkozan Sobei has the most important keramic factory in Kyoto. His wares belong to the florid and highly decorative school; they are, in fact, modernised representatives of the well-known *Awata-yaki*. Kinkozan employs 1,000 workmen, and has three special kilns of his own, unlike most of the other Kyoto ceramists, who burn their ware in one kiln, common to all. There have been eight generations of his family since they became eminent potters, but the present *Kinkosan-yaki*

differs from that formerly produced in several respects. It has suffered from a malady common to all Japanese art manufactures—contact with foreign markets. The ware had an exquisitely soft buff colour, consorting admirably with its sober but rich decoration; and regularity of crackle, as well as fineness of *pâte* were among its chief attractions. But the foreigner who buys to furnish his house rather than to adorn it, thinks pure white preferable to what he ignorantly calls "dirty yellow," and cares little about crackle, and less about *pâte*. This is not written of the foreign connoisseur, but only of the every-day buyer to whose taste, unfortunately, the Japanese artist finds it most lucrative to adapt himself. Kinkozan soon learned by experience that the more brilliant he could make his wares, the better their chance of selling to foreign purchasers, and for a time he sacrificed refinement to ornamentation. But he gradually returned to truer canons, and now the designs made by himself, as well as by his artists, Nagai (Seiko) and Hashimoto (Sekei), worthily represent Japanese taste. Visitors to his store—a spacious place standing in a tasteful garden—may regale their eyes by examining books full of beautiful decorative design, the product of the fancy of three men, and will not attach less value to these happy fancies because the emoluments of the Japanese keramic artists are, in Occidental eyes, a wretched pittance of some £40 per annum.

Tanzan.

Tanzan Rokuro stands head and shoulders above all his fellows in the manufacture of *pâte sur pâte* faïence. His style of work has been in existence since the beginning of the century, but did not come into vogue until the present era. Hozan's celebrated fern arabesques, dating from the later half of the 16th century, and some of the contemporary imitations of Delft faïence, belong to the same category. But never until Tanzan's time was decoration of this kind carried to such an extraordinary pitch of elaboration, and combined with body glazes of such remarkable variety and dexterous manipulation. This admirable faïence found great favour in the United States some years ago, but it is now produced chiefly for the home market, the majority of the specimens consequently taking the form of tiny cups, saki bottles, bowls, and other objects of household use.

Taizan.

Taizan Yohei's productions do not differ greatly from those of Kinkozan, but are, on the whole, truer to Japanese taste. He works on a comparatively small scale, and has not made any material change in his style for several years. The technical features of his faïence occupy a large share of his attention, so that his *pâte* and crackle are of high quality. He has bestowed much pains upon reproductions of certain varieties of the celebrated *Yeiraku* ware, and has also been successful in obtaining very delicate decoration in blue over a soft cream-white glaze.

Shozan.

Okamura Shozan is a potter whose fame in Japan is founded chiefly upon really remarkable imitations of wares by former celebrities, as Nomura Ninsei, Yeiraku, and so forth. These works are in faïence, but Okamura is successful also in the production of porcelain. Of late years he has broken away from the imitative *rôle*, and now turns out many specimens, remarkable for sobriety of style and fidelity of technique.

Dohachi.

Dohachi, whose father and grandfather were celebrated for their faïence, occupies himself principally with the manufacture of porcelain, and succeeds in producing several beautiful varieties. He lives in a most unpretending little place, so small and retired that one would never think of going there in search of objects of art. The man himself, too, like all the art artizans of Japan, seems to deprecate the notion of his own ability, and displays his scanty stock of wares as if he really felt quite ashamed to invite attention to such trifles; yet they certainly deserve it. His blue under glaze, for which he always uses Chinese cobalt, having successfully overcome the extreme difficulties experienced by all potters in employing that mineral, is of admirable tone, though not, indeed, equal to Chinese prototypes of good eras. One of his most remarkable productions is a mirror-black glaze with silver surface-ornamentation and designs incised in the *pâte* after the manner of old bronzes. His use of red *sous couverte* in combination with blue, shows great delicacy of taste, and his *pâte*, the ingredients of which are brought from the island of Amakusa off the coast of Hizen, is close and fine.

Tozan.

Mention must be made finally of Ito Tozan, who, in the early days of his industry, manufactured porcelain only, but has now developed

remarkable ability in the making of faïence. His glazes are a specialty. They derive their distinctive appearance from the fact that the ashes of bamboo-grass and red pine enter into their composition. This process is not new, but Tozan appears to be the only ceramist in Kyoto that now adopts it. He is 44 years of age, and has been working as a potter since he was a boy of 10. During many years the chief object of his ambition has been to develop various *sous couverte* colours in the principal furnace—that is to say, to develop them simultaneously with the burning of the *pâte* itself. He has succeeded remarkably well. Under a peculiar vitreous glaze we find beautifully executed designs in green, black, brown, blue, and yellow. The effect is charming, but, like many other Japanese artists, Tozan thinks much more of the quality than of the quantity of his productions, so that his reputation is still confined to a narrow circle of connoisseurs.

Earthenware and porcelain are manufactured more or less in every part of Japan, but the most noted places are Aichi, Gifu, Saga, Ishikawa, Kyoto, Fukushima, and other prefectures. The total export value amounts to about 1,300,000 yen, chiefly exported to the United States, next to London, and the rest to Hong-kong, France, Germany, China, Corea, British India, Australia, Belgium, and other countries.

The most noted manufactures for export are the Imari wares of the Saga prefecture, the Seto wares of Aichi, the Tajimi wares of Gifu, the Aizu and Soma wares of Fukushima, the Kutani wares of Ishikawa, the Satsuma wares of Kagoshima, the Banko wares of Miye, and the Awata and Kiyomidsu wares of Kyoto Fu, and they consist of flower vases, dishes and plates, tea and coffee sets, flower pots, umbrella stands, wash basins, censers, pots, teapots, and bowls.

Bronze and Iron Work.—Tsubas: their Material.

Little improvement has been made in the material or patina of the Japanese metal work. The display recently at the Burlington Fine Arts Club is of a quality and artistic character not to be excelled, if equalled, by modern products. I will use as an introduction, therefore, to the fine modern work which I show you to-night, Mr. Gilbertson's excellent historic notes on the varieties and mode of production of the tsubas (sword guards) there displayed.

The earliest sword guards were made of iron. This metal was much used also in later times, especially by true warriors and in serious fights. Copper, various kinds of bronze, and the two distinctively Japanese alloys, shibuichi and shakudo, as well as silver, and even gold were likewise employed as the material for tsuba, and also, to a large extent, in their ornamentation. Shibuichi (= one-fourth) should contain one-fourth silver and three-fourths copper; but it often shows a higher per-centage of silver, sometimes even 50 per cent., though sometimes much less. Traces of gold and of lead are frequently present. Shakudo is an alloy of copper, containing from 1·2 to 6 per cent. of gold. Shakudo generally contains also 1 or 2 per cent. of silver, and sometimes a little lead. All the varieties of shibuichi and shakudo present very much the appearance of ordinary copper, until they have received a special treatment. This produces a patina upon the surface, and consists of pickling in a solution which is used at a boiling temperature. In this pickle, shibuichi develops a surface-coating rich in silver, and having various tints and tones of grey, while shakudo becomes of a rich bluish or violet black; in the latter case, the patina, according to the analyses of Professor Roberts-Austen, seems to be a mixture of the suboxides of gold and copper, with a little oxychloride of the latter metal. By the employment of another pickle, copper acquires a beautiful lobster red, or reddish brown colour, due to the presence of a film of the suboxide of copper, and not to any varnish or lacquer. The composition of four of the pickling liquids, used by Japanese metal-workers to produce variously coloured surfaces on alloys of copper, was ascertained many years ago by the late J. G. Hochstätter Godfrey, a German metallurgist, who worked for a time with Dr. John Percy. He presented to the School of Mines, in the year 1873, a set of 24 specimens of metals and alloys used by Japanese craftsmen, and along with these some particulars as to their composition and the ingredients of the pickling liquids employed to colour them. His figures, translated roughly into their English equivalents, are worth reproduction.

For copper the bath was made of—551 grains of crystallised sulphate of copper, 211 grains of verdigris, 5 fluid drachms of vinegar, 1 gallon of water.

For a shibuichi containing 32 per cent. of silver—1,495 grains of crystallised sulphate of copper, 1,495 grains of common salt, 1 gallon of water.

For a shakudo, with 2·9 per cent. of gold,

and a shibuichi having 30 per cent. of silver—427 grains of crystallised sulphate of copper, 85 grains of verdigris, 141 grains of common salt, 85 grains of crystallised nitre, 227 grains of flowers of sulphur, 1 gallon of vinegar.

For the remaining 19 alloys, which include many varieties of brass and bronze, and of shakudo and shibuichi, and of mixtures of the two last alloys, the pickling solution contains—282 grains of crystallised sulphate of copper, 427 grains of verdigris, and one gallon of water.

It is to be noted that most of Mr. Hochstätter's figures for the components of copper alloys imply the presence in the copper employed of 2 or 3 per cent. of antimony; he does not mention arsenic of lead, which latter metal Professor Roberts-Austen has found frequently in his analyses of Japanese copper alloys.

The patina producible on copper alloys by means of these solutions varies a good deal with slight variations in the constituents of the metals operated upon. The results obtained by the old Japanese craftsmen must have been to a great extent, and in very many cases, accidental, for the proportions of the various metals contained in some of their alloys are such as to show that their knowledge of the materials employed was very imperfect.

While on the subject of copper-alloys, a few words may be added to the yellow bronze known as *sentoku*, and the white bronze called *sawari*. Sentoku is reported by Professor Roberts-Austen to contain, in 100 parts :—

Copper	72·3
Zinc	13·1
Tin	8·1
Lead	6·2
Other metals	0·3

It is soft and easy to work, and resembles brass rather than true bronze. It is worthy of remark that at the sale in Paris (1891) of the collection of the late Phillippe Burty, no less a sum than 1,000 francs was obtained for a tsuba in sentoku, made by Yasuchika.

Sawari, white copper or white bronze, is generally known as speculum metal, which contains about 24 to 29 per cent. of tin, the remainder being copper. It is very brittle and of a decided grey hue. It is let into cavities in the metallic base to be ornamented, not by hammering, but by fusion. It is singular that the same alloy, having almost precisely the same per-centage composition, was in use for mirrors by the Phœnicians and the Romans.

A few words concerning the iron so often employed for tsuba, and, indeed, for other accessories of the sword, and for many ornamental and useful objects, may be here introduced. As no analyses of this metal were available at the time, the writer asked an expert metallurgical chemist, Mr. Arnold Philip, then (1889) of the Royal Engineering College, Cooper's-hill, to examine chemically three typical guards. Mr. Thomas Turner, of the Mason College, Birmingham, was so good as to determine their degree of hardness. The per-centage results, with estimations of specific gravity, are given in this Table :—

	I.	II.	III.
Carbon	0·029	0·046	0·057
Silicon	0·046	0·079	0·070
Phosphorus	0·039	0·046	0·046
Sulphur	0·003	0·006	0·004
Copper	trace	trace	trace
Iron (by difference)	99·883	99·823	99·823
Specific gravity, $\frac{15·6°}{15·6°}$ C.	7·869	7·795	7·800
Hardness (T. Turner), 15·6° C.	19°	15°	18°

No. I. was a rough guard of the latter part of the 17th century; No. II. belonged to the 18th century; No. III. to the first half of the 19th. All show a remarkable purity of metal, particularly as regards freedom from sulphur, in which respect these Japanese irons excel all examples of Western origin. The specific gravity is high, the hardness is low, No. 11 being comparable in this character with rolled platinum; the hardness of No. 1 is but that of fluor spar, while a good English razor steel, referred to the same scale, has a hardness of 60°. These iron guards can all be cut with a penknife; it is therefore a mistake to speak of them as if they were made of hard steel. The remarkable purity of the metal is attributable to the special ore and to the special fuel used in smelting it; the fuel was wood charcoal; the ore, magnetic oxide of iron. The reduction of the ore was conducted after what is

known in Europe as the "Catalan" method, and on a small scale. The reduced metal obtained was repeatedly heated and hammered to remove the enclosed and admixed slag. When neither pierced nor encrusted it is highly sonorous, as shown by the guards of Umetada, Miochin, and Kinai. There exist, amongst tsuba, a good many specimens showing a wavy or stringy texture, arising from the welding and twisting together two kinds of iron. The watered appearance thus produced is familiar to Europeans as characteristic of old Damascus blades. In some tsuba, the differing aspects of the two associated metals was further accentuated by means of treatment with an acid, whereby one of them became more deeply eroded or etched than the other.

The great bronzists of the past were held in very high estimation by their chieftains and follow countrymen. There are still in Japan bronzists who are masters in every respect of their art, but who need guiding into some new way of work and production. There are two classes of metal workers : those who reproduce the ancient models, and those who still produce sword guards which have never been put on swords, and which are useless for the ordinary purposes of decoration. When the old feudal system was broken up, swords were no longer worn by the Japanese nobles, and the tsubas and futikashira became curios and objects of collection; but the metal workers knew not what else to make, and tsuba and futikashira are still produced by them, though there are no longer swords to decorate with them, and they are made only for the cabinets of the European curio collector. They are not ancient objects, which had a definite use, and as modern objects they are only of interest, because they recall things that once had a meaning. Thus, it happens that we continue to receive from Japan sword guards, chased with great facility and produced with skill as great as by the metal workers of the old Daimios. It is a false direction of art. We do not want iron sword guards; we do not want kodzukas and futikashira; what we want are vases, hammered figures, caskets, objects for mantelpieces, &c. While encouraging the modern Japanese artists, we ought to be able to obtain from them objects suitable for modern use.

I regret to say that a very large part of the ingenuity of the most accomplished Japanese art workers in metal and in lacquer is devoted to the reproduction of clever forgeries. When I was in Japan I went to the shop of a very distinguished dealer. He showed me many hundreds of objects, and out of these he guaranteed four hundred to be genuine, and gave a written certificate to this effect. After casually looking the things over, I had them sent to the hotel where I was staying for further examination. I had then a good look at them, and found the result so unsatisfactory, that I sent for two of the greatest experts in the town, with the result that we found only five of the pieces were really genuine. While in Japan we had the advantage of the services of the Governor's secretary, so I arranged that this gentleman should come and meet the dealer and hear what explanation he had to offer, which was very long. We then asked him how it was he had certified that some 400 of the objects were authentic of which only five were genuine; we pointed out that either he had been going on selling forgeries for years, or else he did not know his business. He replied with characteristic Japanese courtesy that he was much obliged for the information we had given him, and finally made the following concise and comprehensive apology :—"Old objects very few, buyers very many, my eyesight very bad." I communicated wtth the Minister of the Interior and suggested that it should be made an offence to forge well-known names on curios, but it was explained to me that in Japan there was no such thing as forgery, as a man may use what name he likes. It is however an offence to copy a seal, but that is only an offence against the living and not against the dead.

If we are to assist the bronze artists of Japan we need to send to them the patterns and shapes of the objects that we want made and explain the uses to which we wish to put them. We should demand that the works be signed, but not with the names of a given Miochin, Seimin, or Toun, who perhaps each of them executed fifty or a hundred works, of which there are thousands in Europe, but with the names of living artists, of Jiomi, Gosaburo, Natsuo, Homin, and Shomin, &c. These men are producing magnificent bronzes and we should encourage them by inducing them to send us their best work and by paying proper prices for it. One of my chief reasons in troubling you with these lectures is because I want to protest against this flooding of the English market with the coarsest and commonest works with great names appended to them.

Lacquer.

What I have said about pottery may be repeated in reference to lacquer. We do not,

here in England, appreciate the artistic workmanship, the costly method, and the rare *genre* of lac. Ancient articles of unique beauty and masterpieces of technique are sold in England at prices which are absurdly low. This is true both of old lac and of modern lac; in fact, fine old works are still sold at absolutely nominal values. There are a few lacs which the world will never see again—lacs of Ritsuo, Hanzan, and Korin—which are as unapproachable in their way as any of the great works of the old Italian painters, but are sold for almost nothing. Ten pounds, fifteen pounds, and twenty pounds for a writing-case, people think a very high price. A dozen years ago, beautiful little inros, of the 17th century, by Korin, could be had for five shillings; they are now worth five or ten pounds. They have an artistic value which, in the course of ten, twenty, or thirty years, will rank with that of the great works of the Italian masters. Then, again, we are told that fine modern lac is not to be got. I can only assure you that the Japanese have as fine lacquer works as they ever had in the time of the Shogunate. At the Chicago Exhibition there were two pieces of lac sold by Sumitomo, which cost him $3,000 to produce. When we were in Japan we saw the artists making these very pieces, and the manufacturer told us that they would cost more than the price at which they were ultimately sold. At Chicago, however, they fetched $6,000 (£1,200). I never heard of anybody in England being willing to give so high a price as £1,200 for two pieces of lac. They prefer to buy shady rubbish for as many shillings or pence. In Japan there are artists who are willing to work for art's sake, and in England there are plenty of men who are quite willing to encourage and to foster real fine art, and if only the latter can be brought to appreciate the artistic qualities of the finest modern lac, a very charming art would receive generous encouragement.

Miscellaneous.

VANILLAS OF COMMERCE.

The following particulars respecting vanilla are taken from an article in the *Kew Bulletin* by Mr. R. A. Rolfe, of the Kew Herbarium:—

From historical accounts, we learn that vanilla was used by the Aztecs of Mexico, as an ingredient in the manufacture of chocolate, prior to the discovery of America by the Spaniards, who adopted its use; and Morren states that it was brought to Europe, as a perfume, about the year 1510, at the same time as indigo, cochineal, and cacao, and ten years before the arrival of tobacco.

The earliest botanical notice of the vanilla is by Clusius, in his "Exoticorum Libri Decem," published in 1605. This author had received fruits from Morgan, apothecary to Queen Elizabeth, in 1602, which he described as "Lobus oblongus aromaticus" (p. 72), without being aware of their country or use. He describes them as six to eight inches long by half an inch broad, and terete, from which it is evident that they belonged to the true Mexican vanilla (*V. planifolia*).

In 1651 a figure was given by Hernandez, in his "Nova Plantarum Mexicanorum Historia," (p. 38) under the name of *Araco aromatico*, which shows both the characteristic growth and fruits of the plant, the flowers not being represented. The original of this figure was one of a series of 1,200, executed at great cost in Mexico, by order of the king of Spain, during the previous century. Hernandez only mentions its use as a drug, and gives its native name as "Tlilxochitl."

Piso, in his "Mantissa Aromatica," published in 1658, appears to have first put the name "vaynilla" on record, and also its use as an ingredient in the manufacture of chocolate (pp. 200, 201). He describes it as the fragrant siliqua, or pod, of the *Araco aramatico* of Hernandez, and that it was called "vaynilla" by the Spaniards, who added it to chocolate, not only on account of its fragrance, but because of its medicinal virtues. The name is the diminutive of the Spanish *vaina*, a pod or capsule.

In 1675 Redi figured the pod and seeds, the latter as seen under the microscope ("Experimenta," p. 179). He called it "vainiglias."

Dampier next furnished some important information about the plant. Speaking of the coast of the Bay of Campeachy, South Mexico, under date 1676, he remarks:—"Here are great plenty of Vinellos" ("Voyages," II., pt. 2, p. 123). And at Boca-toro, in Costa Rica, which he visited in 1681, he observed:—"There grow on this coast Vinelloes in great quantity, with which Chocolate is perfumed" (I., p. 38). At a place called Caibooca in the former locality, Dampier remarks:—"We found a small Indian village, and it a great quantity of Vinello's drying in the sun. The Vinello is a little Cod full of small black seeds; it is 4 or 5 inches long, about the bigness of the stem of a Tobacco leaf, and when dried much resembling it: so that our Privateers at first have often thrown them away when they took any, wondering why the Spaniards should lay up Tobacco stems. This Cod grows on a small Vine, which climbs about and supports itself by the neighbouring trees: it first bears a yellow flower, from whence the Cod afterwards proceeds. It is first green, but when it is ripe turns yellow; then the Indians (whose manufacture it is, and who sell it

heap to the Spaniards) gather it, and lay it in the un, which makes it soft; then it changes to a Chestnut colour. Then they frequently press it between their fingers, which makes it flat. If the ndians do anything to them beside, I know not, but have seen the Spaniards sleek them with Oyl" I., p. 234). He further remarks that the vines grow plentifully at Boca-toro, where he had gathered and ried to cure them, but without success, and that he had never met with a Spaniard who could tell him, which led him to think that the Indians had some secret. "Could we have learnt the art of it, several of us would have gone to Bocca-toro yearly, at the dry season, and cured them, and freighted our vessel. We there might have had Turtle enough for food and store of Vinello's . . . . They are commonly sold for 3 pence a Cod among the Spaniards in the West Indies, and are sold by the Druggist, for they are much used among Chocolate to perfume it. Some will use them among Tobacco, for it gives it a delicate scent. I never heard of any Vinello's but here in this country, about Caibooca and at Bocca-toro" (I., p. 235).

The preceding accounts ali clearly refer to the true Mexican vanilla (*V. planifolia*), but in 1796 both Plukenet and Sloane introduce confusion into the records. The former includes the above under his "Vanillia's Piperis arbori Jamaicensis innascens" ("Almagest. Bot.," p. 381), though figuring the true plant (t. 320, fig. 4). The latter, while retaining Clusius' original name, and citing the above references, records it as growing spontaneously in the woods of Jamaica about Aqua-alta (Cat. Pl. Ins. Jam.," p. 70). In his "Natural History of Jamaica," published in 1707, he further observes, "It is said by several that they grow in this island about Aqua-alto, and that before the felling of timber and clearing ground, they were common in the shady bottoms of the inland parts of the island" (I., p. 180), so that it was evidently included on hearsay evidence, and probably the indigenous *V. inodora* (*V. anaromatica*, Griseb.) was mistaken for *V. planifolia*.

The Mexican vanilla was, as already observed, introduced to England very early in the 17th century. The second volume of Miller's "Gardener's Dictionary" appeared in 1739. There the author remarked that he had some branches of the plant, gathered by Mr. Robert Millar at Campeachy, and sent between papers by way of sample, and as the stem appeared fresh, though gathered at least four months, he planted them in small pots and plunged them in a hotbed of tanner's bark, where they soon put out leaves and roots. It is probable that they were soon afterwards lost.

Shortly afterwards Catesby gave a good coloured figured of *V. inodora*, including flowers and fruit, but in his remarks completely confounded it with the true economic plant.

Thus three distinct species had become confused together, and these are all included by Linnæus, in his "Species Plantarum," in 1753, under the name of *Epidendrum Vanilla* (p. 952).

Between 1830 and 1838 Bauer and Lindley's "Illustrations of Orchidaceous Plants" appeared, and we find plates 10 and 11 of the *Genera*, devoted to the structure of flowers and fruit of *Vanilla planifolia*, Andr., "drawn by Mr. Bauer in 1807." This is the first evidence of the production of fruit in Europe, and, as the drawing was made in the same year as Salisbury's figure appeared, it is practically certain that it was made from the very same plant. How the flower became fertilised is not mentioned, perhaps accidentally or by some insect. Morren suggests that the fruit was drawn from a specimen of commerce, but the colour, the uniformly plump texture, and the fact that it is attached to the rachis, all show the contrary; quite apart from the fact that the vanilla of commerce was then thought to be produced by another species, *V. aromatica*, which even Morren states that he sought for in vain in the gardens of London and its environs, and at Kew, and wrongly supposes it to be the plant cultivated by Miller in 1739. Morren is also wrong in stating that the "vanilla planifolia" (?) of Lindley's Herbarium is "the very same plant drawn in flower by Mr. Francis Bauer," for it came from a botanie garden near Moscow, as the ticket "ex horto Gorenski" proves.

To Professor Charles Morren, of Liege, belongs the credit of first producing fruits in quantity, and of proving that *V. planifolia* was the source of the true vanilla of commerce. By a particular method of treatment adopted he succeeded in obtaining 54 flowers on one plant, and these he fertilised artificially, and obtained the same number of pods. The following year a crop of about 100 pods was obtained from another plant by the same method. His paper, "On the Production of Vanilla in Europe," was read before the British Association, at Newcastle, in 1838, and published in the following year ("Ann. Nat. Hist.," ser. 1, III., pp. 1–9). He also succeeded in tracing his plant back to the one which originally flowered in the collection of the Right Hon. C. Greville, and also its introduction to Java, as has been already pointed out. Thus Morren first proved the necessity of artificial fertilisation, and he attributed its not bearing fruit in the East Indies to the absence of the species of insect which doubtless existed in Mexico, and there fertilised the flowers. He also suggested that vanilla might be produced in intertropical colonies, and also in European hothouses, by artificial fertilisation. Deltiel states that artificial fertilisation was first practised by Neumann, in 1850, in the Jardin des Plantes, but Morren makes no mention of it. In 1845 Blanco described a species of vanilla from the Philippines, which he received from his friend Azaola, under the name of *V. majaijensis* ("Fl. Filip., ed. 2., p. 593), but it has since been referred to *V. planifolia*, and thus, if the determination is correct, it may have been at some time introduced from Mexico by the Spaniards.

Blanco describes the pod as not aromatic, but it may not have been mature when he received it.

Mr. Rolfe has described 50 known species of the genus, and his monograph on the subject will be communicated to the Linnæan Society.

FRUIT CULTURE IN MALAGA.

The cultivation of the vine in the province of Malaga dates back at least to the time of the Roman occupation of that part of Spain, and according to the United States Consul at Malaga it may have been cultivated even anterior to the time that Spain was a conquered province of Rome. Pliny mentions vine growing in Alora, Alhaurin, and other places in the province. Arabic writers refer to the beautiful and fruitful vines and delicious wines of Malaga. All this goes to show that at least for 1,800 years the cultivation of the vine and the making of wine has been carried on in and about Malaga, and has always formed a very important branch of her trade and commerce. At the present time it is estimated that there are not above 60,000 acres under vine cultivation in Malaga free from phylloxera or disease. About 100,000 acres are partially destroyed, and about the same quantity totally destroyed. Some twenty-five varieties have entirely disappeared. Very few of the Malaga grapes are shipped to any foreign country. The muscatel would not stand the journey, so that from what are now grown in the province, raisins are made. The American vine, *Riparia*, seems to approximate more closely to the muscatel in flavour and quality for making raisins than any other foreign wine that has been introduced. It has also the quality, thus far, of withstanding the attacks of the phylloxera on account, it is said, of the hardness of the root; it will not, however, flourish on a calcareous soil. The life of the healthy muscatel is from forty to sixty years, and it begins to yield after about three years; when grafted upon another vine, the graft yields in about two years; the vine, however, on which the muscatel is grafted must be from two to three years old before the grafting can be done, and this makes about five years after the foreign vine is placed in the ground, whether by means of seed, or from a slip, before there is any fruit. The number of kilogrammes of raisins depends largely upon the locality and on the character of the soil in which the grapes is grown. In general, however, it may be said that 100 kilogrammes of grapes will yield from 33 to 40 kilogrammes of raisins. Almeria ships a large quantity of grapes to foreign countries every season. The tens of thousands of barrels of Almeria grapes shipped to England, the United States, France, Germany, and other countries, are grown by hundreds of small farmers on small patches of land, on hill and mountain side, in the valley, or on the plain. As regards oranges, the varieties grown in Malaga are numerous, at least, in the names given to them, though in quality, size, shape, and flavour there is but a sligh difference between most of the varieties grown Those known as "China Dulce" and the "Chin Agria" are practically the only ones exported t foreign countries, being shipped chiefly to France England, and Germany. Both of these varieties ar nearly round, and of different sizes. Of the smalles size, 720 are placed in a crate; of the next size larger 420 to 500 are packed in the export crate; and o the largest size about 300. These oranges are callec "China" because they were said to be brought to the continent of Europe from China. Anothe variety, called the "Cajel," is in shape, size, quality and flavour similar to the China. This variety i consumed in Spain, as it will not keep for export There is another variety, called "Grano de Oro," which, it is said, was brought from the island o Malta to Malaga some forty or fifty years ago. It i now grown in some of the towns of the province but not to any extent. Another variety is known as the "Caña Dulce." This variety had its origin in Malaga, having been obtained by grafting with othe varieties of oranges, and, some say, with sugar-cane It is much more juicy than the "Grano de Oro," with a more palatable flavour, the sweetness not having the insipidity which characterises the "Granc de Oro." In shape and size it is about the same as the "Grano de Oro." The production is small, and is consumed in the country. Arabic writers speak of the lemon tree in Andalusia during the latter part of the Moorish rule in Spain. The method of propagating the tree at first seems to have been to graft a slip upon the citron tree. The result of this grafting, from some cause, seems to have given lemons of two different shapes, the one elliptical, the other almost round. The former are called "Reales," and the latter "Castellaños." It is these two classes that are exported, the former being the most highly appreciated. Of the above classes there were exported, in 1894, 12,020,880 lbs. weight. The inferior grade is shipped to the United States, the second grade to England and Germany, and the first grade to France and Holland. The old method of propagating the lemon tree by grafting it upon the citron has been abandoned, because horticulturists have found that grafting on the "Naranja Agria," or tree of the acidulous orange, gives better results, and produces a healthier and more juicy fruit. This is partly accounted for by the fact that the roots of the orange tree go deeper into the earth than the roots of the citron, and consequently are not affected so much by drought, and that the tree is freer from disease than the citron tree. When the lemons have attained their maximum growth, and while yet green, they are picked from the tree. After picking they are piled up under the tree, remaining in the pile from twenty-four to forty-eight hours, for the purpose of seasoning sufficiently so that they may not become stained or spotted while being taken from the places where grown to Malaga, to be prepared for shipment. They are transported

om the orchards in large two-wheeled carts, enerally drawn by oxen. On arriving at Malaga, hey are taken from the cart, placed in small piles pon the ground near the warehouse of the shipper, nd girls and women begin at once to wrap them in issue paper for shipment, after the classification for he different foreign markets is made. The inferior uality, going to the United States, is placed at once nto the boxes in which they are shipped. The voman engaged in this operation wraps the lemons p and packs them at the same time. The first uality, however, after being wrapped with more are, is placed by the women in a basket, and the acking is done by another person. Three to five days usually elapse after picking the lemons from the tree before they are wrapped and ready to be shipped, and frequently they remain a day or two at the wharf before being placed on board. They may remain, before being shipped, as many as twenty-five to thirty days, provided they are kept dry. They are brought to Malaga from surrounding towns at distances ranging from six to thirty miles. When wrapped and packed they are perfectly green. They ripen and become yellow during the time of their transportation. There is no artificial process employed in Malaga, as some suppose, for ripening and yellowing the lemon. This is not considered necessary by the shippers. The time elapsing from the picking of the lemon for export until it reaches its destination is sufficient to ripen and yellow it. Both ripeness and yellowing might be hastened, however, by placing the lemons in a pile when picked, covering the pile with cloth and allowing them to remain under the sun, thus covered, for three or four days, but they must not be exposed to the rain. Consul Burke says that more attention is being given to the culture of lemons than formerly, in consequence of which the quality is improving, the number of trees is increasing, and the quantity obtained from each tree is increasing also.

NEW RAILWAYS IN RUSSIA.

There are many new railways projected or in course of construction in Russia. According to a Russian paper, the Committee of Ministers and Department of the Imperial Council have jointly examined and approved various schemes for the construction of important lines, among others one for connecting Pskow with Bologoé, on the Nicolos line. This branch will be 330 verstes in length (verste = ·663 of a mile), and will be a continuation, on the one hand of the Rybinsk-Bologoé, and, on the other, of the Pskow-Rega lines, so that the latter place will be connected with Rybinsk by a direct line of 900 verstes. By this means the grain from the Volga can be carried not only to St. Petersburg, but also (when the Neva is frozen over) to Rega, a port which remains open to navigation a much longer time. In addition to serving as a means of transit for the Volga trade, the Pskow-Bologoé line will bring into direct communication with one another such places as Rega and Moscow, Moskow and Pskow, Yaroslaw and Rega, Nijni-Novgorod and Rega. It will also pass by the town of Valdai, and will afford railway communication for a district where it is greatly needed. The districts of Pskow and Pookhow are rich in flax, which, by means of the new line, will be placed not only on the inland markets, but also exported abroad *viâ* Rega, together with grain of all kinds, hay, wood for building purposes and fuel, tar, manufactures of wood and leather, game, fish, petroleum, sugar, salt, and alcohol. The *Messager Officiel* reports that a special Commission sat last year to consider a scheme for connecting the White and Baltic Seas by means of a short railway, without losing sight of the two lines (Vologda-Archangel and Perm-Kollas) now in course of construction. The result is that the Ministers of Finance and of Ways and Communications have advised that technical studies be made on the spot, at the expense of the State, with a view to the construction of a line from St. Petersburg, or one of the stations on the Nicolas railway, to Kem, about 750 verstes in all. These preliminaries will cost about 80,000 roubles. The actual construction of the line will be proceeded with as soon as the necessary expenditure has been authorised, commencing with the section from St. Petersburg to Petrozavodsk. This line will be of particular service to the province of Olonetz, which has hitherto been at the mercy of the grain merchants, who, especially in winter, have asked what price they liked for corn; it will also greatly facilitate the transport to the capital of game and fishery products, and of the products of the mines and forests of the governments of Novgorod, Olonetz, and Archangel. The recommendation of the Ministers have been adopted, and they received the Imperial sanction on the 28th April last.

NIGHT REFUGES IN ITALY.

For the purpose of giving shelter for the night to poor, destitute, and honest artisans out of work, whose spirit forbids them to beg or accept the degrading hospitality of the police, the United States Consul at Turin says that a few prominent, liberal-minded, and public-spirited men in that city met together in 1887 to organise the "Societa per gli asili notturni," that is to say, a society to offer night refuge to homeless working men. A solid stone edifice of massive structure, built for, and used during the exhibition of 1884, was used for the purposes of this refuge. The refuge is situated at the corner of the Via Burdin and the Corso Massimo d'Cozelio, opposite the Valentino Park. It is a high, one-storey building. To the right of the large entrance hall are the offices and the disinfecting and washing rooms; the reading-room, dormitory, and

two smaller rooms for families are on the left of the entrance. The building is heated by steam, lighted by gas, has running water and sanitary arrangements of the latest improved type—accommodations which, even in some good Italian hotels, are often sadly missed. The receiving hour is at 6 p.m., or later, according to the season. The newcomer's name, nationality, age, religion, and trade are registered; all nationalities, ages, and religions are treated alike. After an obligatory shower bath, clean clothing is given to the applicant for admission, while his own in the meantime is disinfected and cleaned by chemical process, if necessary. Then he has leisure to go into the reading-room, or can smoke in the adjoining garden and under the portico. A doctor is at hand to attend to any ailments or wants, the medicines being kept in a chest standing in the office. At 9 p.m. a large bowl of meat soup, with plenty of vegetables, is served to the hungry, and at 10 p.m. the doors are closed, and the inmates can go to bed, thirty of which are in the large dormitory. The beds are of iron; they have a mattress, two pillows, linen sheets and covers, blankets, and a counterpane, all scrupulously clean and neat. The dormitory is well ventilated, and has a tiled flooring. Should a father or mother with children apply for admittance, two separate rooms are set aside for such purposes, containing each three beds; single women are never admitted. At 7 a.m. in summer, and 8 in winter, the inmate is obliged to leave the refuge, the place receiving a thorough cleaning and overhauling every day. No particular surveillance is necessary, only two attendants being kept to look after things generally. The refuge, however, is in telephonic communication with the *Questura* (police head quarters) and the principal hospitals, in case of emergencies. So far, however, says Consul Mantius, these places have never been appealed to. The applicant is allowed to use the refuge four consecutive nights, but this can be extended to seven nights. He is permitted to return to the refuge after a lapse of two months. The refuge contains many clever sketches in water-colour and crayon, made by poor artists who have found in this place a night's rest and a good meal, on their way across the Alps to or from the Eternal City and elsewhere. The institute is a purely private enterprise, supported by the contributions of annual, honorary, and perpetual members. The establishment once received a subsidy from the Government of £40, and from the municipality of £60. It receives donations also from the foreign consulates in Turin, with the exception of the Commercial Agent of the United States, who has no funds at his disposal for such purpose. During last year the total income of the refuge was £328, out of which 13,877 people were given shelter. Next to the Italian, the largest contingent applying for admission are French (1,222), Swiss (490); Germans and Austrians follow, and even Egyptians and Moors are received in the institution. The management of the refuge is non-sectarian. Catholics, Protestants, and Jews work together solely fo[r] one object—the good of their fellow men. In con[-]clusion, Consul Mantius says that it is astonishin[g] what private charity has done and is still doing t[o] lessen the misery in Turin. In regard to distributin[g] charity systematically and practically, the benevolen[t] Turinese is, he states, far ahead of his kind in all th[e] cities he knows in Europe, as well as in the Unite[d] States.

General Notes.

Shipping in French Ports.—It appears fro[m] the shipping returns that have recently been issue[d] by the French Government, that the number o[f] vessels entering and clearing in the various ports o[f] France in 1894 amounted to 45,320 as compared wit[h] 51,573 in 1891, the latter year being taken for purposes of comparison, as it was the last preceding the introduction of the new French Customs Tariff unde[r] which very high rates of duty were levied. The falling off in the number of vessels is particularly marked in the case of those sailing under the French flag—14,765 as compared with 17,070. As regards foreign vessels, the numbers fell from 34,503 to 30,559. The total tonnage of the vessels entering and clearing, which in 1891 was 25,137,000 tons fell to 22,580,000, of which 7,626,000 were in French vessels (against 9,049,000), and 14,954,000 tons under foreign flag (against 16,086,000 tons in 1891).

The Barcelona Textile Industry.—The manufacture of woven goods has become a very important industry in the province of Barcelona. The goods produced are exported in large quantities to many different parts of the world, and the demand for them, says Consul Bowen, is increasing very rapidly. During the last seven years the quantity exported has doubled, the actual amounts being as follows:—1884, 431 tons, and in 1894, 996 tons. The countries to which these goods were exported in 1894, in the order of quantities exported thereto, were as follows:—Philippine Islands, Puerto Rico, Cuba, France, Great Britain, Colombia, Canary Islands, Venezuela, Trinidad, Mexico, Fernando Po, Singapore, Germany, Martinique, Italy, Uruguay, Belgium, Egypt, Morocco, Brazil, Argentine Republic, Aden, Portugal and Chile. The cheaper descriptions of goods have the better sale, and are able to compete with those of foreign nations. The more expensive goods are sold in Spain, as the heavy protective tariff prevents foreign goods from competing with them. The chief centre of production in the province of Barcelona is the town of Mataro, which produces every week 80,000 kilogrammes (kilogramme = 2·204 lbs. avoirdupois) of shirts, chemises, socks, and stockings.

Journal of the Society of Arts.

No. 2,235. Vol. XLIII.

FRIDAY, SEPTEMBER 20, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

"*OWEN JONES*" *PRIZE*.

This competition was instituted, in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon condition of their expending the interest thereof in prizes to "Students of the School of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The following is a list of the successful candidates:—

Carpenter, Alfred, Birkbeck Institution, Bream's-buildings, Chancery-lane, E.C.—Design for a tapestry.

Collingwood, John H., School of Art, Battersea, S.W.—Design for a carpet.

Gregory, Frederick W. C., School of Art, Nottingham.—Design for a cabinet.

Möller, Oscar P., School of Art, Battersea, S.W.—Design for a stencilled frieze.

Smith, Philip W., School of Art, Cavendish-street, Manchester.—Design for a stencil wall decoration.

Trower, Charlotte, School of Art, Hertford.—Design for a mosaic floor decoration.

The next award will be made in 1896, when six prizes will be offered for competltion.

Proceedings of the Society.

CANTOR LECTURES.

JAPANESE ART INDUSTRIES.

By Ernest Hart, D.C.L.

Lecture II.—Delivered May 20, 1895.

Japan, as is well known, was a closed and perfectly self-contained country, from the time of Hideyoshi, the early part of the 17th century, until American, English, and other powers combined to force Japan to open her ports to foreign ships and trade. This was barely more than a quarter of a century ago, but in this short period Japan has not only learnt ths arts and methods of European civilised life and national defence, but she has mastered the intricacies and difficulties of foreign trade, has impressed her own individuality on all the nations of Europe, and has created an export and import trade which, during the last twenty-five years, has shown a continuous and marvellous progress. The imports of Japan for the year 1868 were valued at about 10,000,000 of dollars, in 1890 they had risen to 81,000,000. The exports, which were valued in 1868 at 15,000,000, had risen in 1891 to 142,000,000. The imports from Great Britain, of which the first accurate record begins with the year 1873, were then of the value of 11,000,000 dollars; in 1890 they were of the value of 26,000,000 dollars. The only country which comes near Great Britain in these figures is China, where the value of the imports was in 1873 about 10,000,000, and in 1891 13,000,000. Germany which, in 1874, sent goods to Japan of the value of 728,000 dollars, now sends to the value of 5,000,000, while India, which in 1877 sent 3,000,000 dollars worth, sent in 1890, 9,000,000. Japanese exports to Great Britain stand at the present date at 5,000,000 worth of dollars, about the same value as in the year 1873. On the other hand, the United States, which, in 1873, took 4,000,000 dollars worth of Japanese commodities, took, in 1891, 29,000,000 dollars worth. France, which in 1873 took goods to the value of 5,000,000 dollars, in 1891 imported 15,000,000 dollars worth, and China, which, in 1873, took to the value of nearly 5,000,000 dollars worth of Japanese goods, received, in 1891, 18,000,000 dollars worth. India, which in 1877 took only

333,000 dollars worth of goods, imported in 1891 989,000 dollars worth. Germany, to which Japan exported in 1873 170,000 dollars worth of goods, received, in 1891, to the value of 1,500,000 dollars. During the last few years a great change has taken place in the nature of the trade of Japan, owing to the progress of Japanese industries, thus the imports of raw material are increasing by leaps and bounds, at the expense of manufactured goods. Japan imported in 1894 eleven times the quantity of raw cotton taken in 1877, and since the same year her export of fabrics manufactured in Japan have increased nearly 400 per cent.; in fact, Japan has become a formidable competitor with England and with India in certain lines of cotton goods. At the end of 1885, the number of cotton-spinning factories in Japan was 21, having a total of 62,320 spindles. In 1892, according to the official returns, there were 37 cotton-spinning mills, with 446,376 spindles. The rate of wages for male operatives may be estimated at about 4½d. per day, and for females at about 2¼d. These wages cover a working day of 11½ hours.

The curious thing is that the workers are happy, live well, and save on these wages solving a problem we still have to study; how to be happy on 4d. a day. When the new treaty revision comes into operation, there is no reason whatever why English capital should not be largely employed in Japan, and why English manufacturers could not have their Japanese factories just as they have their American and French prototypes.

According to Mr. Enslie, a highly competent Consular authority, in the one respect of strength only can the Japanese workers of either sex be said to be inferior to their English compeers. In delicacy of touch, in deftness, they are far superior; in intelligence they are at least equal They are also amenable to discipline; strikes and combinations in antagonism to their employers are as yet practically unknown to them, and experts, who have had the opportunity of observing the female spinners at work in the factories in Japan, have been unable to detect any inferiority in their general efficiency to the Lancashire operatives. The cost of labour is no inconsiderable element in the prime cost of a bale of yarn, and looking at the favourable conditions under which Japanese work in this respect—conditions still further favoured by an abundant supply of cheap coal almost at their doors—it seems no unreasonable anticipation that they may, in no distant future, prove formidable opponents to the English as they already are to their Bombay competitors.

It is impossible, however, to refer to the industrial arts of Japan, or to Japan at all at this moment, without first congratulating the people of that remarkable country on the wonderful success which they have attained in the art in which they had not been credited with having reached—that supreme degree of skill which we now know belongs to them, namely, the art of war. The success which Japan has reached in her great war against China, has astonished all of us. Those who knew Japan best, must recognise that such progress as she has made in the organisation of her army, and in the adoption of the principles and the practice of war, as exemplified by the details of this Chinese campaign, form a remarkable tribute to the wonderful power of adaptation which Japan possesses, and also to her original genius in the art of war. It will be seen that remarkable as have been the achievements in marching, in commissariat, in organisation, and in transport, the total cost of the keep of the soldiers during the whole of the war did not exceed 3½d. a day per man, and that the men have marched at double the rate that has ever been known in any European war. Whole bodies of men have been transported on foot at the rate of 15 to 20 miles a day, carrying their commissariat with them on their backs. I venture to predict that when the annals of this war are laid before the European public, there will be found much to wonder at.

Art Industries.

Cloisonné.—With regard more especially to art industries, *cloisonné* stands at the head, though the actual value of production is small, amounting only to $40,000. It is, however, becoming a branch of Japanese art of unequalled importance, especially the *cloisonné* without *cloisons* of Namikawa Suske of Tokio. On examining fine specimens of Japanese *cloisonné*, and comparing them with French enamels, it will be seen that they have attained a perfection which no other *cloisonné* makers can reach. The great French makers have made attempts to rival the Japanese, but a very fine French *cloisonné* would, in comparison, be twenty times as dear, and not to compare with the Japanese production in delicacy and perfection of work. In modern arts, Japan has made such great progress during the last twenty years, that

amateurs can only collect old *cloisonné* as a matter of curiosity, the modern being far superior to anything which the ancient Japanese artist ever produced.

In other industrial arts great progress has been made in porcelain, which has produced the artisans of Arita (Hizen), of Seto (Owari), of Mino, and of Ayezu, not counting the numerous decorators of Yokohama and Tokio, Kioto and Kobe.

Any reference whatever to the subject of porcelain cannot be made without citing the names of a few of the learned potters of Japan, whose works are most beautiful. As artist-potters, the following are noted:—Eokemato Hayata, Ino-uye, Riosai, Mme. Hattori Kozan, &c., who have each produced a special kind of pottery, faïence, or porcelain, bearing their name, and having world-wide fame.

The English Oriental merchants do not distinguish between the magnificent work of the great modern Japaneses potters and the ordinary commercial work. We want some modern dealers, who can recognise and value the work of the great Japanese potters, and who will set it aside as an artistic production, and not sell it indiscriminately with ordinary merchandise. I hope someone will give the English collectors the opportunity of seeing the work of certain men, whose names I have already given. The products of Makuzu Kozan, shown at Chicago, were marvellous. In America they fetch great prices, but here we have not yet sufficiently learnt to distinguish between the art work of great men and the showy work of inferior artists. Another potter, who is quite unrivalled, is Seifu, than whom Japan has never had a greater or more marvellous artist. Each of these potters work in his own house with his own kiln, never producing two things alike; each piece of work bears the impress of an individual mind.

As regards ivory carving, this is a new industry which in eleven years has become of unprecedented importance, and the number of artisans employed in it may be counted by thousands. Then follows incrustation work, in which Kataoka Guenjiro has attained a degree of execution unequalled by any worker in mosaic or marqueterie in the world. Work in metal, from the melting of bronze to fine chasing, increases annually in quantity, but does not improve in quality.

Fine art industries have made great progress in the last twenty or thirty years. From 1850 to 1875 there was a period of relapse, especially where the encouragement given by Government was indirect. This is shown at the present time in a striking manner by the excellent results of private initiative, whilst the pressure exercised by Government gives results, which if not *nil* are mediocre. As for example, the foundation of the Bijitsugako Fine Art School, where the only art trades taught are lacquer work, ivory, casting, chasing, &c. The pupils are apprentices, and are modest and sincere, but they have not yet fully justified the high expectations with which the school was started. We must not omit to mention the great progress in arts of European importation, such as photography, printing, photo-chromo-lithography, etching, wood-engraving, &c. By the side, however, of the comparatively slow progress of artistic trades, the industry in common articles has made such immense strides that the European and American markets are being inundated with low-priced goods, while really artistic productions can with difficulty find an entry into Europe, and consequently scarcely obtain at present, fair prices. It is probably because the prices of modern artistic articles are relatively high, while fine old artistic specimens are proportionately very low, that the highest modern Japanese art has not yet had a fair chance. In short, the excessive importation into Europe of cheap modern *camelotterie*, and the low price of beautiful old articles, are the two chief causes of the want of success of Japanese modern art industries in the European markets. Witness, for example, the heavy losses, speaking from a commercial point of view, of the Japanese section at the Chicago Exhibition. The exhibit was one of great beauty, and produced at great cost, but it was found impossible to obtain the prices asked for the exquisite art objects shown, most of which were therefore returned to Japan. The most beautiful modern articles of art industry remain, as a matter of fact, in Japan, and will not come into Europe until they have attained a certain antiquity. In ten years' time old pieces of art work will be worth ten times what they are to-day, and, consequently, works of modern art, which are as yet only looked upon as artisans' work, will begin to be eagerly sought after in Europe, and will attain an immensely higher level of appreciation and of price.

Silk-Cotton Fabrics.

As regards the industrial arts of Japan, the greatest progress has been made in silk. The silk industry of Japan began to assume importance from about 1869-1870, when

European silk-spinning machines were first introduced. At the present time, silk-spinning factories are met with everywhere.

Since the improved machines were introduced in 1870, the manufacture of raw silk has made rapid progress, and its market value equals the best European machine products. Raw silk is now the most important product of the Empire, and occupies the foremost place in the exports of Japan. The total export for 1887 was of the value of 19,280,000 yens, and had risen in 1891 to 29,000,000. Of this amount, Great Britain took to the value of 737,000, the United States 17,000,000, and France 10,000,000 yens. In silk goods there has been even more marked increase during the last five years; the total value of silk goods exported in 1887 was only 135,100 yens, the export value for 1891 was 1,763,000, France taking to the value of 1,000,000 yens, the United States upwards of 500,000, and Great Britain 90,000. In silk handkerchiefs a great trade also has sprung up, which now amounts to nearly 3,000,000 yens, the United States taking two-thirds of the whole amount, Great Britain coming next, taking to the value of nearly 500,000, and France 168,000 yens. Australia takes 36,000 yens. Other silk manufactured fabrics, curtains, table cloths, &c., were exported in 1891 to the value of 206,000 yens, the trade having doubled within five years.

An exhibition of Japanese silks, at Lyons, has just been held, and the Japanese have indeed carried the war into the heart of their competitors' country. The Lyons papers and the Lyons experts are full of praise of the Japanese silks, which are no longer exported as the raw material but in the manufactured state. The town of Lyons bought from Japan in 1892 893 kilos of raw silk, representing a value of 40,000,000 francs; one-sixth of the total amount of silk used at Lyons coming from Japan. During the first eleven months of 1892 Lyons brought from Japan manufactured silk to the value of 66,000,000 francs, which is a remarkable proof of appreciation.

Cotton Printing.—The methods by which fabrics are printed in colours is an art peculiarly Japanese, and till described by my wife in the papers she sent home from Japan on the "Art Industries of Japan," and which were published in the *Manchester Guardian*, the method of the process was hardly known in England. In every instance stencil plates of paper are used. The cutting of these stencil plates alone is a marvel of dexterity and taste. They are cut with a sharp knife in a double layer of paper, the two papers are pasted together, and from these stencils the most lovely patterns are produced. As to teaching the Japanese manufacturer what patterns, sizes, and widths are required in the European market, I am very hopeful that when the new treaty comes into operation, European managers will have more direct relation with Japan, and then we shall learn better what are the possibilities of the country, and the Japanese will learn what are the needs of England.

Very beautiful effects are produced by the combination of stencil printing, embroidery, and hand-painting on the same piece of work. I do not think that anything like this has been attempted in England, and we might very well take a lesson from the Japanese in producing similar pictorial effects for house decoration.

Embroidery.—This is an art in which the Japanese are unequalled. Not only are their designs exquisite, but their methods of obtaining effects are unique, and cannot be imitated. An embroiderer twists his thread, combining the colours he requires, on a hook beside his embroidery frame as he works, and his models are frequently drawn straight from nature. The finest and most costly embroideries never leave Japan, and one must go to the showrooms of Nishimura and Kawashimaya, at Kioto, to see them. The Mikado and the Japanese noblemen will give very long prices for fine embroideries and weaving; and we hear of a curtain made for the Japanese Parliament, for which £12,000 was given in Japan. The wages of embroiderers are higher than those of any other workmen; and it is possible for a noted embroiderer, whose services are in great demand, to earn as much as 5s. a-day. It is much to be hoped that European influence, and the demand for cheapness, will not lead to the decadence of this charming art in Japan.

Colour Printing.—The Japanese broadsides were published in sheets, one sheet giving the whole of the subject or forming only a segment of the complete picture. Most commonly three sheets were required to make up the scene depicted, but sometimes the number rose to four or five. The purchaser usually had these mounted and preserved in books or rolls.

The art of colour printing was not confined to the production of theatrical and other broadsides. It was also used in the illustration of books, and in the decoration of New Year's cards (*surimono*), fans, umbrellas, and letter-

paper, as well as for many other purposes; but the greatest variety was to be found in the *nishikiye*, although the book and the New Year card often displayed more evidence of care in technical details.

The *surimono*, or New Year cards, which came into fashion in Yeddo in the last quarter of the 18th century, are gems of chromoxylography, and display the technical resources of the engraver at their best. They are usually of quarto or octavo size, printed with great care on thick creamy paper, adorned with designs by well-known artists of the popular school, and bearing some little conceit in the form of a verselet or proverb. The best period is between 1800 and 1840.

There are no coloured engravings in the world that may be compared with those of Japan, in the long period from the coming of Torii Kiyonaga to the passing away of Utagawa Toyokuni. In them the eye is beguiled by a brush stroke of ineffable caligraphic beauty and by a tender harmony of colour that cheers, but never fatigues the senses. In most of the popular broadsides of this time an almost feminine gentleness pervades the choice of motive and its treatment, and it is but rarely, as in some of the earlier work of Toyokuni and his pupil Kuniyasu, that a stronger chord is struck. As a scheme of chromatic decoration they are scarcely to be surpassed and have rarely been equalled, and Professor Anderson confidently predicts that the time is not far distant when the sheets which brought to artist and engraver the pittance of a mechanic, and were sold for a very low price in the streets of Yeddo, Osaka, and Kyoto will rank in the estimation of the collector with the masterpieces of the engraver's art. They are already highly valued, and are becoming scarce. Fine specimens vary in price up to £40 each.

Before we introduced to the notice of Japan our cheap and facile aniline dyes, their colouring was delicate, subdued, and exquisitely beautiful. The processes by which the prints were produced were of the most simple and rudimentary kind. If the illustration was for a book the artist drew his drawing upon thin paper, and then he handed it on to the engraver who pasted it on to a block. The original drawing was destroyed in cutting the block. In colour printing hand pressure alone is used and the colour is wiped off so as to produce that graduated colouring which is so marked a characteristic of Japanese colour prints. Only recently, in going over my collection of colour prints I discovered an old book which on examination I found to contain the original drawings made by Toyokuni for a book never published. As the pictures are drawn in thin unsized paper, the artist could not go over his work again, so in many places where he felt he could better the original he has pasted over it little pieces of paper on which head or hands are re-drawn. This series of original drawings is particularly interesting because Tokoyuni was an artist, in his way, little inferior to Hokusai. He was a great master of line in black and white. These *nishikiye*, as the prints are called, reached their perfection between the beginning of this century and the time when Japan was opened to Europe, and from that moment aniline colours have superseded the original delicate Japanese colouring. Almost immediately after the opening up of the country to Europe the art of colour printing began considerably to deteriorate under European influence. We can prevent this retrogression, by patronising only the best examples of colour prints. There is a charming periodical now being produced in Japan, called "Kōkwa." It is a book of illustrations, in which men, like Mr. Okakura and others, interested in the best work, are endeavouring to preserve the highest grades of Japanese art. I would appeal to my readers not to allow the best kind of modern Japanese work to die out. I have been very glad to see that the modern pictorial work of Watanabe Setei has been appreciated here at its true value.

As a last word, I would say, discourage cheapness in Japanese art, discourage grotesqueness, discourage the constant effort which is now being made to palm off modern forgeries by appending to them ancient names. Ask for the best from Japan, and you will get it, for there are there artists, art workmen, and art lovers, who, as of old, lovingly delight to produce perfect work in charming arts.

Miscellaneous.

*THE SEARCH FOR COAL.**

It has become the turn of geologists to help those who would find coal. The trial at Dover was successful, several hundred feet of coal measures having been found without reaching their base, but with several beds of workable coal. Fairly good reasons

* From the Presidential address of W. Whitaker, F.R.S., to the Geological Section of the British Association.

can be given both for and against the selection of many places for trial except in and near London, where no geologists would recommend it from evidence possessed. The area within which the borings that reach older rocks in the London basin is enclosed is an irregular pentagon formed by joining, in the order named, Dover, Richmond, Ware, Culford, Harwich, Dover. The greatest distance between any borings is from Dover to Culford, about 86 miles. Therefore it is over a large tract that we have good reason to infer that older rocks are within reasonable distance of the surface, nowhere probably as much as 1,600 feet, and mostly a good deal less. Outside this tract several trial borings have been made. Near Burford, in Oxfordshire, carboniferous rocks, consisting of coal measures, have been found at a depth of 1,180 feet, and pierced to a depth of 230 feet. In and near Northampton, carboniferous beds, older than the coal measures, have been found, and at Scarle, south-west of Lincoln, the older rocks have been reached at the depth of 1,500 feet, beginning with the Permian, the carboniferous occurring after another 400 feet. These have been pierced for 130 feet.

Over a large part of South-Eastern England, reaching northward and westward of the London basin, though the older rocks are hidden by a thick mantle of Jurassic, cretaceous, and tertiary beds, they yet seem to be rarely at a depth that would be called very great by the coal miner. They are distinctly within workable depths wherever they have been reached. There is no area of old rocks at the surface in our island, south of the Forth, in which coal measures are not a constituent formation. It is not, however, to the more northern and distant tract—*i.e.*, north of the Forth—that we should look for analogy to our underground plain of old rocks; but rather to more southern parts, to Wales and to Central and Northern England, where coal measures are of frequent occurrence. There is no reason why we should not suspect a like occurrence of coal measures, in detached basins, in our vast underground tract of old rocks. Certainly trials should be made to see if such hidden coal-basins can be found.

The Dover boring has proved the presence of coal underground in Eastern Kent, along the line between the coalfields of South Wales and Bristol on the west, and those of Northern France and Belgium on the east. The long gap between the distant outcrops of the coal measures near Bristol and Calais has been lessened very slightly by the working of coal under the Triassic and Jurassic beds near the former place, but much more by the French and Belgians, who have not only proved the extent of the coal measures beneath the Jurassic and cretaceous beds along their borders, but have largely worked the coal found. The Dover boring has still further lessened the gap.

The Stutton boring cannot be said to be either a success or a failure, as far as coal is concerned, but it is certainly a success in the matter of reaching the old rocks at a depth of less than 1,000 feet. And every boring is almost certain to afford some knowledge that may help in future work. A boring that may at first seem to be a failure, from striking beds older than the coal measures, may some day turn out otherwise. The coalfield along the borders of France and Belgium is sometimes affected by powerful and peculiar disturbances, by faults of comparatively gentle inclination (far removed from the usual more or less vertical displacements) which have thrown coal measures beneath older beds in large tracts. This was once a theory, but is no longer so, for much coal is now worked below the older beds that have been pushed above the coal measures by the overthrust faults.

Another point to which attention has been drawn by Continental geologists is an apparent general persistence of disturbances along certain lines, or, in other words, the recurrence of distubances in newer beds in those parts where earlier movements had affected older beds; so that, reasoning backward, where we see marked signs of disturbance for long distances at or near the surface, there we may expect to find pre-existing disturbances of the older beds beneath. This, however, is a somewhat controversial question, and much remains to be done on it; but, should it be proved as a general rule, it may have much effect on our underground coal. The question of the possibility of finding and of working coal in various parts of South-Eastern England is not merely of local interest, it is of national importance. The time must come when the coalfields that we have worked for years will be more or less exhausted, and we ought certainly to look out ahead for others, so as to be ready for the lessening yield of those that have served us so well.

HOUSING OF THE WORKING CLASSES IN BERLIN.

Berlin has done much to improve the condition of the labouring classes as regards their housing, says the United States Consul-General in that city, but rents have risen and wages have fallen. Capital has been embarked in the building of new quarters of the city, and tenement buildings have been neglected. As a consequence, there has been a failure to provide small buildings, apartments, and small suites of rooms, and, in many cases, the poor have been driven still closer together in such buildings as previously existed. The moving of factories employing many hands towards suburbs which are not inhabited by the rich, and the rise in the rents in the city proper, have forced the poorer classes towards the outskirts. Efforts have been made to provide labourers with small separate houses still farther out, but this is not practicable on any large scale for the really poor. They must live near their work and near the city centres. It is recognised that labourers must live near together in order to live on their present wages.

In 1890, the population of Berlin was estimated at 1,436,233, of whom 265,101 paid no taxes. The taxes paid by the remainder were proportioned as follows: — Persons paying income tax, 120,412; "class tax," by families under the 900 marks limit, 622,550; "class tax" by families over the 900 marks limit, 428,170. Reduced to heads of families, 318,755 persons paid taxes under the 900 marks limit, and 162,540 persons over the 900 marks limit (mark = one shilling). The large proportion of families for whom cheap lodgings are absolutely necessary may be seen from the number of families taxed under the 900 mark limit. But prices of the simplest lodgings bear no relation to average wages and salaries. An average labourer, with wife and child, should have from 1,575 to 1,750 marks (£78 to £87) annual income to occupy the smallest quarters, reckoning his rent at one-fifth his income. The average daily wage of an adult male is only 2·40 marks (about 2s. 4d.) which at 300 working days gives but 720 marks (£36) annually. Now the rent of one room and kitchen in the back part of the house, where air is poor and often foul, is reckoned at an average of from 230 to 270 marks (£11 10s. to £13 10s.); rent of a room with two windows, or one-windowed room and kitchen, 315 to 350 marks (£15 15s. to £17 10s.); rent of an apartment with a two-windowed front room, one-windowed back room, corridor, and kitchen, averages 450 marks (£22 10s.). A workman, with wife and child, must, therefore, spend about 315 to 350 marks (£15 15s. to £17 10s.) annually on his rent alone, or nearly one-half of what he makes as an average wage earner. Hence it is necessary that wife and children must work to help pay the family's way, and any small floor, bed, or sofa space that can be squeezed out is let to more or less permanent tenants for the night. These sub-lodgers are called *Schlafburschen*. They are of both sexes and all ages, and comprise the hard-working, sober, young labourers, steady girls, widows, and widowers, as well as the floating population, which deals in and distributes vice, infectious diseases, and punishable crimes. Efforts have been made to stop this sub-letting, and the Berlin police are active in their endeavours to regulate and check such abuses. One evil result of such herding together of the sexes is the number of illegitimate children born to very young girls. The tenement house in Berlin is not so easily recognised as in some other cities, owing to the admirable cleansing and police systems, and the appearance of the houses, which is often imposing; but the houses themselves cover much misery. A common thing is a broad, high, massive front, broken by an arched passage, which leads to one, two, or three courts. The back courts are often ill kept, narrow, and foul, violating the rules which prescribe so many cubic feet of air to the human body. They are often old buildings, by no means calculated for the human strain to which they are now subjected, and lack conveniences, especially water-closets. In these houses the worst mortality occurs in garrets; then come the cellars. Garrets are more fatal, perhaps, because of the greater cold, or the strain on the old and sickly, from having to ascend and descend stairs, or, it may be, that garrets are slightly cheaper than cellars, which latter are largely rented by dealers in old rags and iron, &c.; so that the poorest of the poor people, already weakened by disease and hunger, take to the garrets, and are predisposed to greater mortality. Cellars are also occupied by men and women, who take charge of the cleaning of the houses. Even in the best houses the gate-keepers or *portiers* live in very badly lighted, badly warmed, and ill-ventilated rooms, considerably below the level of the street. In the back parts of tenement houses these evils are much worse. In 1880 as many as 100,000 people lived in cellars. In that year attention was drawn to the excessive crowding of the floating population in large single rooms, locally called *Pennen*, which were really breeding grounds for epidemics. The worst of these were done away with then, but there is a constant tendency to their revival in defiance of the police. Cellar dwellers suffer from eye diseases and rheumatism, owing to the lack of light and the dampness of the walls. As lately as 1893 the number of cellar dwellers was reckoned at 100,000, and there is no reason to estimate them at a lower figure now. They exist in the suburbs where rents are relatively cheaper, as well as in older quarters. Large houses in the suburbs often have horse and cattle stables at the back; the effluvia and drainage from these stables affect the cellars especially. Under such conditions the misery of the tenants is enhanced by the fear of landlords that the rent will not be paid. The German laws as to detaining furniture for rent is still unfavourable to the poor, and the latter therefore hesitate to buy decent furniture. On the other hand the landlord is slow to repair tenements, knowing that his rooms will receive hard usage and that he cannot expect his tenants to stay long. Rents are still taxed in Berlin. While Berlin is overbuilt for rich people and those with moderate and fixed incomes, it is underbuilt for the labouring classes.

THE SNOWDON MOUNTAIN TRAM-ROAD.*

The idea of a railway up Snowdon was first suggested as long ago as 1871, when the late Sir Richard Moon, at the opening of the Llanberis-Carnarvon Railway, referred to the possibility of such an undertaking. Several attempts made since that time to set it on foot have failed, but in November last year the necessary arrangements were made with the landowner, and the works were begun in the middle of December.

The line is set out with a special regard to the tenants' interests, at the same time to secure,

* Paper read by F. Oswell, A.M.Inst.C.E., before Section G, at the British Association meeting at Ipswich.

wherever possible, the finest views for the passengers consistent with easy gradients and light earthworks.

Leaving the Llanberis Station, which stands on the main road, midway between the L. and N. W. Station and the Victoria Hotel, the line follows the stream as far as Cae Esgot, where it crosses it in front of the old King's House, passes near the Methodist Chapel (Hebron) on the left, and at two miles reaches and crosses the bridle path by a bridge. The first half-way house is passed 60 feet, and the second 180 feet below, the tramroad at this point arriving on the watershed which it follows for half a mile, and crossing the bridle path again at 3½ miles, 2,550 feet above the sea, remains below it (at one point as much as 200 feet below) until 4¼ miles, when path and tramroad run nearly side by side to the summit, terminating at the site of the hotel that is to be built here, 3,500 feet above the sea, and 50 feet below the plateau where the present huts stand. Here a fine view is obtained over the Bwlch Main Watershed towards Beddgelert, as well as in other directions.

The length of the line is 4⅝ miles, the total rise 3,140 feet, the steepest gradient 1 : 5·5; the average gradient 1 : 7·83. Two miles of the entire length are in curves, of which there are thirty-four in all, with radii of 4, 5, 10, 12, and 20 chains. There are to be terminal stations at the top and bottom, three intermediate equidistant passing places, and an additional station at the waterfall (Cennant Mawr).

The works consist chiefly of a viaduct 500 feet long near the beginning of the line, composed of 14 brick arches 30 feet span carried on masonry piers; a second viaduct of 4 similar arches crossing the side of the waterfall ravine, an arched bridge of 50 feet span over the stream, and 5 smaller bridges.

The permanent way is all of steel, the rails being of the Indian State Railways pattern, 41¼ lb. to the yard, 9 metres long, carried on rolled steel sleepers, to which they are attached by clips and bolts. The sleepers are spaced throughout 0·90 metre apart, and the fish plates are 3 ft. 6 in. long, with slots in the ends to admit the clip of adjacent sleepers, each pair carrying six fish bolts.

The rack is of the "Abt" pattern, and laid double throughout, the bars being 1·80 metre long, spanning two sleepers, and breaking joint with each other. They are ⅞ inch thick, on grades of 1 : 10, or flatter, and one inch thick on all steeper grades. They are carried on rolled and milled steel chairs, which are attached by heavy bolts to the sleepers.

The locomotives have been built at Winterthur in Switzerland with the object of saving delay, and they contain all the latest improvements known for this class of engine. They carry two double differentiating pinion wheels on the axles of the "driving" wheels, which latter run free on the axles, so that the engine cannot travel on adhesion rails alone.

There are two cylinders, 12 in. diameter by 24 in. stroke; the rigid wheel base is 4 ft. 5 in. There is a third axle carrying trailing wheels under the cab. There are eight brake blocks, four to each pinion. These brakes may be worked by hand, but are applied automatically by steam power if a certain fixed rate of speed is exceeded. There is also an air-brake worked in conjunction with the hand-brake in descending, which retards or arrests the motion by forcing air into the backs of the cylinders after steam has been cut off.

All the permanent-way material has been made by English firms. The engineers to the undertaking are Messrs. Sir Douglas Fox and Francis Fox, London. The contractors are Messrs. Holme and King, Liverpool.

THE SPANISH HAT TRADE.

In the town of St. Martin de Provensals, near the city of Barcelona, is situated the only manufactory of woollen hats in Spain. It was established in 1892, at a cost of £18,000. Three thousand hats can be turned out each day. The demand in Spain is for about half that number, the remainder being exported to Puerto Rico and the Philippine Islands. Besides this manufactory there are five or six others where beaver hats are made, but they rarely produce more than 200 hats each. In the woollen hat factory, from 130 to 180 men are employed, and they produce two sorts of hats, one soft and the other hard. The soft hats are sold at from 8s. to £1 sterling, per dozen, and the hard hats at from 29s. to 33s. per dozen. About £1,600 worth of both kinds are at present exported. It is stated that the outlook for the trade of hats is not good just now, as Germany, Italy, and England have entered into competition with Spain in supplying the Spanish colonies with hats of the same kind as those made in Spain, and unless some kind of protection is given to the Spanish trade, Germany will drive Spain out of Puerto Rico and the Philippines, and put an end to the export trade in hats from Spain. Straw hats are made in Spain, and large quantities of these are exported from Malaga. Only the cheaper kinds of hats are made in the country, the best, as a rule, being imported from England and France.

THE GREEK EMERY INDUSTRY.

Some interesting information is given in a report recently made by Consul Cottrell, of Syra, upon the emery districts of the Island of Naxos. It appears that the period in which the working of emery commenced for purposes connected with the manufacturing industries is not known with precision, but, according to tradition, it cannot have been prior to two centuries and a half ago. The existence of emery, however, and its inherent properties of subduing hard metals, sharpening edged tools and weapons, and polishing iron and steel, were familiar to the ancients, to whom the subsequent generations

are indebted for the advantages derived by the application of this mineral to the industrial arts. The art of engraving figures and inscriptions on gems and cornelian by means of emery was also handed down by the ancient dactylioglyphs, as also that of working diamonds, emeralds, and sapphires, which, however shapeless and dim when found in nature, were given the requisite form and lustre by means of emery. The mineral was even found useful for medicinal purposes. The emery districts of Naxos are situated on the north-eastern side of the island, between the villages of Apiranthos and Vothri, and are spread along the eastern slopes of Mount Koronis. The localities are distinguished by the following names:—Aspalathropos, Kakoryacas, Sideritis, Macheras, Stravo-Laugadi, Fira-Stefani Pita, Tiropita, Kako-Vriada, Amalia, Spilies, Renidi, Gremno, Pesules, Mavro-Faranga, and Kastelaki. The mineral occurs in lenticular masses within calcareous rocks, superposed on layers of schist. These primordial azoïc rocks originally contained the substances from which emery was produced in the course of centuries by the combined action of hydration and metamorphism, which action is testified by crystallisation, such as in the passage of limestone into saccharoidal marble, with which the island abounds, and of silicious clays into schists. The anomalous emery beds generally occur beneath layers of dolomite and schist, disposed alternately and approximately parallel within a depth of 600 to 1,000 feet from the surface, and their discovery is due to an upheaval of the strata, occasioned by the welling up, to an extent of some 3,000 feet, of the granite rock masses which constitute Mount Koronis. The emery mines are not confined to Mount Koronis for the adjacent islands, Paros, Keraklia, Sikino, Amorgos, and Anaphi, contain a certain amount of emery, though of an inferior quality. In like manner the marble of Paros, called "Lychnitis," from which the finest existing specimens of ancient Grecian sculpture were obtained, is nearly identical with that found mixed with the emery masses of Naxos, hence the supposition that these beds are connected from one to the other island is not irrational. The exploitation of the emery deposits is, however, actually being carried on under most unsatisfactory conditions. The labourers are natives of Apiranthos and the neighbouring villages, who have been enjoying the peculiar benefit of exploiting the emery by inheritance for many years past. As a matter of fact, the labourers actually look upon the emery districts as their own property, and are left to work by themselves, under no supervision or guidance whatever. Some restrictions are, however, exercised at the shipping places of Liona and Montzouna Bays, a distance of about four miles from the nearest emery quarries, where a Government official superintends the selection and weighing of the mineral before it is shipped. A condition imposed by the Government is that the labourers employed—generally amounting to some 300—should all be married. It consequently happens that many are induced to enter into matrimony when still in their teens. The emery masses to be found above the surface are taken at random, and disposed of without any regard to method. As emery is very hard and resists any boring instrument, the natives to facilitate quarrying have recourse to the action of heat by kindling fires round the block to be worked. Under the direct action of the heat the natural cracks af the blocks expand, thus enabling the introduction of steel levers, and by this means the mineral is reduced to fragments. The emery blocks are reduced to a convenient size for transport, varying say from one foot square as the maximum down to the smallest chips, and is put on board a vessel just like a cargo of coals. It is not converted into powder, as we are accustomed to see it in everyday life, until it reaches the manufactory where it is destined for commercial uses. Emery powder can now be obtained of the very finest grain imaginable, and of any coarseness desired either in bulk or on paper sheets. The quality of the mineral, as already stated, is not uniform everywhere; sometimes it occurs almost exempt from foreign ingredients, and is essentially composed of alumina of a bluish colour; at other times it is mixed with crystalline limestone, oxide of iron, &c., the presence of these impurities decreasing its value in proportion. Naxos emery was originally found remarkably superior to any other by the consumers, and although it continues to be superior to the Asia Minor product, there has been it is said some prejudice in England that the quality produced is indifferent ever since the expiration of the last concession, viz., in 1890. The cause of this is only to be attributed to the system of exploiting the mineral and to the fact that quantities of it rejected by former lessees were apparently disposed of without being previously subjected to examination. Up to 1889 the exportation was restricted by the Government to a certain limit, only 2,000 tons being allowed to be exported annually. In 1894 the exports amounted to 3,950 tons. The total quantity of emery existing at Naxos is estimated at 20,000,000 tons. Consul Cottrell says that if the exploitation of the Naxos emery mines were undertaken by European experts, and carried out with the aid of all the available appliances of modern science, then there is no doubt it would enter a new phase of development, the extent and importance of which would be enormous.

PRODUCTION OF GOLD, PLATINUM, AND SILVER IN RUSSIA.

In the year 1893—the latest year for which returns are available—the production of gold in Russia amounted to 2,736 pouds (poud = 36 lbs. avoirdupois), an excess of 104 pouds over the production of the preceding year. This output was derived from the following mining districts:—The Ural contributed 738 pouds; Tomsk, 473; Irkutsk, 1,392; the mines

of the Emperor's Cabinet in Nerchinsk, 121; Altais, 12; and the Grand Duchy of Finland, less than one poud. The United States Consul at St. Petersburg says that, in the whole Ural region, in 1893, there were 2,253 gold mines in private possession, of which only 807 were working; 13 mines, belonging to the Government, were leased to private persons. The laboratories of Ekaterinburg, Tomsk, and Irkutsk, in 1893, received 2,712 pouds of *Schlichtgold*, out of which were obtained 2,639 pouds of *Ligaturgold*, in 5,754 bars, which contained 2,304 pouds of chemically pure gold, and 221 pouds of silver. The St. Petersburg mint received 2,662 pouds of *Ligaturgold*, for which the holders obtained 30,625 gold roubles. Formerly, platinum was produced exclusively in the Ural district. In 1893, 311 pouds of platinum were obtained in all, which was 32 pouds more than in 1892. The price of platinum fluctuated between 7,000 and 8,000 roubles per poud. The platinum is generally purified in foreign factories, therefore Russia only exports it raw. Only two factories for the cleaning of platinum exist in the whole of Russia, the Tomtelev factory and the laboratory of Kolbe, both situated at St. Petersburg. Silver in Russia is chiefly produced in the Altai and Nerchinsk districts, which mainly belong to the Imperial Cabinet. It is also produced in the Caucasus, the Kirghiz steppes, and in the south of Russia. On the average, the mines of the Imperial Cabinet produce 275 pouds annually. It is not anticipated that an increase in the production of silver will take place in the near future. The total production of silver in Russia, in 1893, not taking Finland into consideration, where only 54 pouds were extracted, amounted to 729 pouds, including the 221 pouds derived from the *Schlichtgold*, which was 13 per cent. less than in 1892. In 1893, 94,000 workmen were employed in gold mines, of whom 48,000 were in the Ural mountains, where the workmen earned from 15 to 30 roubles per month, the women from 10 to 15 roubles, and the children from 10 to 18 roubles. During the year 64 accidents occurred in the Ural gold mines, of which 18 were fatal; in the Siberian gold mines, 264 accidents occurred, of which 17 were fatal. It is expected that as soon as the Siberian railway is completed, the gold mines in that region will resume work with renewed activity.

THE LABOUR BOURSE AT NANTES.

An office was established at Nantes, in 1893, where working people, male and female, out of employment could register their names and addresses, giving all particulars as to age, sex, trade, experience, &c. This costs the person who registers about 5d. only, and when the applicant has secured a position, an additional sum of 4d. is paid. This office has grown considerably, and is now known as the " Bourse de Travail." Even at the present low price of registration and remuneration upon securing employment, it more than pays expenses, according to Consul Savage, who has lately been devoting some attention to the labour movement. The scheme of establishing a labour bourse at Nantes originated with the workmen themselves, and employers were quick to see that men and women who organised for such a purpose deserved patronage. Only two years have elapsed since this bourse was founded, but if an employer wants a workman now, he knows exactly where to go to obtain all particulars about him. A man or woman with a bad character cannot register. The bourse prides itself upon being able to recommend workpeople who are seldom, if ever, dismissed for incompetence or bad behaviour, and the merchants have realised this, and rely upon the bureau. It is very useful to both capital and labour, and, since its inauguration, strikes in the district have greatly decreased.

General Notes.

Japanese Art Industries.—Mr. E. Gilbertson writes that he has no claims to the authorship of the historic notes on Japanese Tsubas in the Introduction to the Catalogue of the Burlington Fine Arts Club Exhibition, which is credited to him by Mr. Ernest Hart (see *ante* p. 873, col. 1), these "excellent notes" being the work of Professor Church.

Fish Supplies and Imports.—In his address to the Zoological Section of the British Association at Ipswich Prof. Henderson remarked that the demand for the produce of the seas is very great, and our choicer fish are becoming rarer, and the prices are rising. The majority of our oysters are imported, and even the demand for muscles cannot be met. The Scotch long-line fishermen alone use nearly a hundred millions of mussels every time all the lines are set, and many tons of these are annually imported, at a cost of £3 to £3 10s. per ton. If squid (cuttlefish) could be obtained reasonably, and in sufficient quantity, it would probably prove more valuable even than muscles. A fishing firm in Aberdeen last winter paid over £200 for squid bait for a single boat's lines from October to December, and there are fifty or sixty of such boats north of the Tyne. Here is a nice little industry for anyone who can capture or cultivate the common squid in quantity. Whether the wholesale introduction of the French method would be a financial success is doubtful; but as innumerable young muscles perish round our coasts annually for want of suitable objects to attach to, there can be no doubt that the erection of simple stakes or plain *bouchots* would serve a useful purpose, at any rate in the collection of seed.

Journal of the Society of Arts.

No. 2,236. Vol. XLIII.

FRIDAY, SEPTEMBER 27, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRIZES FOR DESIGNS FOR FURNITURE.

The Council of the Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Memorial Committee, on condition of their spending the interest thereof in prizes to "Students of the Schools of Art, who in annual competition produce the best designs for household furniture, carpets, wall-papers, and hangings, damasks, chintzes, &c., regulated by the principles laid down by Owen Jones."

The prizes will be awarded on the results of the annual competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in the competition.

The next award will be made in 1896, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones's "Principles of Design," and the Society's Bronze Medal.

Proceedings of the Society.

CANTOR LECTURES.

COMMERCIAL FIBRES.

By D. Morris, C.M.G., M.A., D.Sc., F.L.S.,

Assistant-Director of the Royal Gardens, Kew.

Lecture I.—Delivered March 18, 1895.

The commerce in fibres is admittedly of great importance. It is one of the largest in the United Kingdom. The total imports of raw fibrous material during the year 1893 was of the value of £50,000,000 sterling. The total exports—chiefly manufactured goods—were of the value of £74,000,000 sterling. Hence the total turnover in fibrous substances in 1893 was of the estimated value of £124,000,000 sterling. Of this large amount, India and the Colonies contributed about 10 per cent. of the imports. The Table given below will indicate the sources whence the fibrous materials received in the United Kingdom were derived :—

Value of Imports During the Year 1893.

	Foreign Countries.	British Possessions.
	£	£
Cordage material	502,145	185,475
Cotton, raw, yarn, &c....	34,618,079	1,202,790
Flax, raw, &c.	1,103,377	1,474
Hemp, &c.	2,213,735	238,022
Jute	3,721,973	3,640,185
Paper material :—		
Esparto, wood-pulp, &c.	2,054,696	*40,170
Linen and cotton rags..	199,155	4,859
Pulp of rags, &c.......	231,119	44,990
Total	£44,644,279	£5,357,965

Summary.

Foreign countries	£44,644,279
British possessions	5,357,965
	£50,002,244

The small proportion of fibrous substances received from British possessions is very striking. This was not due to the fact that fibres were unsuited to the circumstances of Colonial and Indian industries. India itself grows immense quantities of cotton, but 42 per cent. of it is shipped to foreign countries. There is no doubt room for considerable expansion in the cultivation of fibres in British possessions. For instance, the Dominion of Canada is capable of growing excellent flax, specimens of which were shown at the Colonial and Indian Exhibition of 1886. Natal possesses a local variety of hemp (*Cannabis*) of singular merit for textile purposes. Queensland can produce a *Sida* fibre better than Indian jute. Victoria, in the north-west portions of its territory, has promising lands for flax-growing that would support an industry

* Wood pulp from Canada.

far more profitable than wheat growing; while New Zealand has only to make its Phormium fibre available for the higher textiles to establish an industry of the greatest value. The plant is abundant everywhere in a wild state, and it is a most persistent member of the local flora. Its systematic cultivation is, therefore, hardly necessary for some time to come. The Maori cleaned fibre is better selected and better prepared than the machine fibre, and this indicates the direction in which improvement should take place.

The West Indies are finding it difficult to grow sugar to compete successfully with beet sugar, and if a change of culture were imperatively demanded, some of the islands could grow the best sorts of sea-island cotton, and so go back to the position of a hundred years ago, when the West Indies supplied nearly all the cotton required for the world's markets. It is also open to them to grow ramie, pre-eminent amongst vegetable fibres for strength, fineness, and lustre.

In the Bahamas a large effort is being made to grow Sisal hemp, a valuable white rope fibre extensively used both in this country and in the United States. Mauritius hemp has been produced for many years, and the industry has been well sustained in spite of periodical depression in prices. West Africa has lately produced from the wine palm a bass fibre of considerable value. This is obtained also in Ceylon and India from the Palmyra palm. In all these possessions the prospects of development are encouraging, provided, however, the industries are not overloaded with capital, and the cost of production is reduced within the lowest possible limits.

Commercial fibres have hitherto been regarded as a heterogeneous group of natural phenomena. They have been studied piecemeal, rather than in a systematic manner based upon the morphological or chemical character of their constituent elements. Botanically, they might be dealt with according to the sequence of the natural orders of the plants yielding them. Such a plan should not, however, be strictly followed, as we would have to deal at one time with different sorts of fibres—say bast fibres and seed hairs—yielded by one and the same plant. While, therefore, the botanical arrangement will, in the main, be followed, it will be necessary to depart from it whenever certain morphological and structural distinctions arise requiring special treatment.

Vegetable fibres have received considerable attention of late years. Numerous writers have described their origin and characteristics, and a large mass of information has been accumulated respecting them. The fibres of our Indian Empire have been specially studied. Two early investigators in the field of fibre research are deserving of special mention. Dr. Hugo Müller, in "Die Pflanzenfaser" (Brunswick, 1876), a work that first appeared as a report on the vegetable fibres at the Vienna Exhibition of 1873, may be said to have started the chemical method of examining commercial fibres and laid the foundation of much of what has been done since that time. The late M. Vétillart ("Etudes sur les fibres végétales textiles," Paris, 1876) investigated the microscopic structure of commercial fibres, and drew careful and accurate deductions between the structure of the fibres and their value in commerce.

Since 1876, the field of investigation, from the chemical side, has been successfully occupied by Messrs. Cross and Bevan. The former prepared the official report for the Royal Commission on the miscellaneous fibres shown at the Colonial and Indian Exhibition, 1886, and was further associated with Dr. George Watt, in the preparation of a "Report on Indian Fibres and Fibrous Substances," published separately (London: Spon, 1887). Quite recently Messrs. Cross and Bevan have published a valuable text-book on "Cellulose" (London: Longmans, 1895), giving an outline of the chemistry of the structural element of plants, with reference to their natural history and industrial uses. The botany of vegetable fibres, especially in regard to those that have come into prominent notice of late years, has been very fully treated in various articles in the "Kew Bulletin" (London: Eyre and Spottiswoode, 1887-95). Detailed information respecting the fibrous plants of India may be obtained from Watt's "Dictionary of the Economic Products of India," vols. I.-VI. (London: Allen and Co.); while general information may be gathered from Spon's "Encyclopædia of the Industrial Arts," 1881, in a series of articles on "Fibrous Substances." At the close of these articles there is a very extensive bibliography of works dealing with vegetable fibres.

In works treating of the economic properties of tropical and sub-tropical plants nothing is more common than the references frequently made to the fibre-yielding properties of these plants. There are, no doubt, thousands of plants capable of yielding fibres of some sort.

For instance, we are informed that there are over 300 fibre-yielding plants found in our Indian empire. Of these at least 100 are said to afford strong and useful fibres, which are regularly used by the natives of India. Only 30 are, however, worthy of European recognition, while those actually utilised for commercial purposes do not exceed ten.

The total number of fibres employed in European manufacture is singularly small. In fact, it is little more than it was fifty years ago. Some new fibres have no doubt been introduced, but they are, in many cases, of lower textile value, and have been chiefly used as adulterants of the more expensive and higher fibres. A great change has, however, taken place in the quantity actually produced of all fibres, and, as already shown, the commerce in fibres is now of great importance. The principal vegetable fibres in order of commercial value are—cotton, jute, flax, hemp of different sorts, paper material (esparto and wood pulp), cordage material, coir and brush material, and raffia. This is a singularly small list.

It has been asked whether the general neglect of many really valuable fibres known to exist in many parts of the world arises from some defect in the cultivation, in the want of suitable appliances to extract the fibre, or in the incidents of distribution and commerce. It is difficult to understand why some undoubtedly valuable fibres have hitherto been quite neglected. The fibres themselves have been carefully and exhaustively examined, and they have proved of great merit. In spite of this, however, they are still unknown in commerce, and such an intrinsically inferior fibre as jute occupies a position second only to cotton and flax.

It will be the object of these lectures to bring into prominence several fibres quite as deserving of notice as those already in use. They will be found to possess qualities in some degree superior to those now in commerce, while their special adaptation for cultivation on a large scale in British possessions in the tropics should bespeak for them the attention they deserve.

Those anxious to study the plants yielding commercial fibres cannot do better than visit the large collections—possibly the most complete existing anywhere—at the Royal Gardens, Kew. Specimens of nearly all the plants mentioned in these lectures are to be found there, in a living state, duly labelled. In the Museums of Economic Botany I. and II. may be seen the fibres themselves, in different stages of preparation, as well as the manufactured articles prepared from them. The guide-books to the museums (obtainable at the entrance gates) indicate exactly the portions of each museum where the specimens are to be found. Students and men of business can thus make their own observations in this country almost as well as if they visited the tropics.

Essential Element in Fibres.

In spite of the complexity and variety of the fibres known in commerce, and the different forms presented by the plants yielding them, the essential element on which their value depends is always the same. A fibre, to be of value, must consist of a substance known chemically as cellulose. The larger the percentage of cellulose, and the purer the quality, the better, in a general sense, is the fibre.

Cellulose has been described as the substance which constitutes the essential part of the framework of plants. In the young cells of plants the wall is formed of a delicate, but firm and elastic membrane. This wall consists of cellulose, which is, chemically, very similar to starch. The strength and elasticity of all parts of plants are ultimately due to the cell-walls, which serve as a firm supporting framework for the whole structure. During the process of growth in plants, many cells become incrusted with colouring matter, resins and other substances, which, in some parts, as in the heart wood of trees, fill up the entire cavities. Some tissues, however, remain with little or no incrustation, and, although their walls are thickened, they consist almost wholly of cellulose. We have good examples of such cells in the perisperm of certain seeds, such as those of the ivory palm and the date palm, and in the pith of the rice-paper plant (*Aralia papyrifera*) and the shola or pith helmet plant (*Æschynomene aspera*). The fine floss of cotton, kapok, and the seed hairs known as vegetable silks, are almost pure cellulose, as also such manufactured vegetable fabrics as linen, hemp, and unsized white paper. Cellulose, in its more compact form, is not coloured by solution of iodine, but if previously disintegrated by sulphuric acid or caustic alkali, it produces a violet-blue colour with iodine. This serves as a convenient test for cellulose in all microscopic preparations.

Cellulose, perfectly purified, is white, translucent, and of the specific gravity of about 1·5.

It is insoluble in water, alcohol, and oils, both fixed and volatile. Well bleached linen is composed entirely of cellulose, hence its value for paper-making. Under ordinary conditions of the atmosphere cellulose is practically indestructible. For instance, in the Kew Museum, pieces of linen rags are shown taken from between undisturbed bricks in the temple of Hawara, built in B.C. 2500. They are thus over 4,000 years old. Cellulose is disintegrated by means of acids, hence vegetable fibres can be distinguished from those of animal origin, such as wool or silk. From a wool-cotton fabric the cotton is easily separated by soaking the fabric in dilute sulphuric acid. The disintegrated cellulose is removed, leaving the wool unaffected. The actual amount of cotton in a wool-cotton fabric can be thus estimated. The capability of cellulose of being gelatinised in cupro-ammonium solutions, and rendered of industrial use in "Willesden" and other goods, will be discussed later.

Fibre Bundles and Fibre Cells.

Although cellulose is found in all parts of plants, the parts that are of special value for yielding commercial fibres are certain cells which occupy a definite area in each plant, varying, however, greatly in the extent and form of distribution, as well as in the length, thickness of cell wall, and the nature of the adjacent tissues.

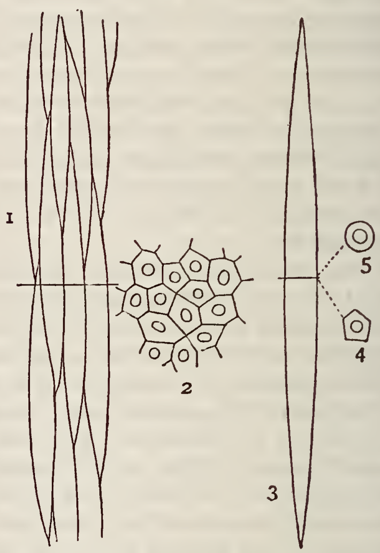
Fibrous cells are usually long, thick-walled cells, with sharply, or sometimes bluntly, pointed ends. The wall is generally thickened all over, but there may be a few small, narrow pits, where the wall is left thin. The fibrous cells, unlike the vessels (through which the nutrient fluid passes to build up the plant), keep their living contents, and do not fuse with one another. They are, in fact, long narrow tubes, tapering at both ends, holding a fluid sealed up in the central cavity. The chief function of the fibrous cells in plants is a mechanical one; they serve merely to give rigidity to the plant, and prevent it from collapsing.

Fibrous cells overlap one another, and form, in the mass, a tissue, called prosenchyma. Numerous instances, showing the position and arrangement of fibrous cells, will present themselves later.

In the great division of plants known as Dicotyledons (having four or five parts to the flower, and the veins of the leaves forming a network), the fibrous cells are to be found in the middle layers of the bark. In such parts are to be found the fibrous, or bast cells, of flax, hemp, jute, China grass, and paper mulberry.

In Monocotyledons (with parts of the flower usually three or six, and the leaves with parallel veins), the fibrous or bast cells are found built up with vessels into a composite structure known as a fibro-vascular bundle. These bundles are irregularly distributed in fleshy leaves or in stems, and are not localised into a continuous tissue as in the Dicotyledons. The fibre-yielding plants amongst Monocotyledons are grasses, agaves, and other amaryllids, musas, and palms.

Fig. 1.



Diagrammatic Representation of a Fibre Bundle.

1. Longitudinal aspect showing the arrangement of the cells. 2. Transverse section exhibiting the relative position of the individual cells, the thickness of the cell wall, and the cavity. 3. An isolated fibre cell, much enlarged. 4. Section of a cell showing the polygonal form due to compression. 5. The normal form.

In extracting fibre from plants by any process that will break up the tissue in which they are built up, the first aggregate that presents itself is a fibre bundle. This is composed of a number of cells adhering together and forming the unit from which the spinning thread is formed. In a cross-section a fibre bundle shows a number of cells with walls more or less thickened, and a central cavity. Owing to the pressure to which the cells have been exposed, the walls are usually hexagonal, not round. If a fibre bundle is treated with alkalies it will be resolved into its component

units, and we have the ultimate fibre cell. In cotton and other seed hairs the ultimate cell is already isolated as an elongated tubular cell attached to the seed. In bast tissues, as has been shown, the ultimate cell is obtained only by a thorough disintegration by means of alkalis.

As regards the fibre bundles (being the spinning units), it is of great importance that they should be uniform as regards length and diameter. Further, they should have tenacity, flexibility, and smoothness, so as to give them good spinning qualities. The fibre cells, on the contrary, are to be examined first for length, then for thickness of wall, size of cavity, tapering ends, and, lastly, for uniformity in size and composition. Perhaps the most important factor of all is the length of the ultimate fibre cell, for although it is not the spinning unit, it is in a very direct sense the essential factor of strength and durability of the manufactured goods. In the subsequent process of bleaching the fibre bundles are disintegrated and the individual cells isolated. As a striking instance of the value of length in the fibre cell we may compare the fibre cells of jute and flax. In jute they are only 3 mm. long, in flax they are 40 mm. long. In the case of jute, according to Messrs. Cross and Bevan, bleaching means "rotting"—that is, the whole fabric falls to pieces.

Investigation of Raw Fibrous Materials.

The first step necessary in the investigation of plants for fibre purposes is to determine the position of the fibre bundles and their relative abundance in regard to other tissues. In the case of Monocotyledons, sections would have to be taken across the leaves, petioles, or stems. In Dicotyledons the stems alone are likely to yield fibre, and these only in the peripheral layers of the cortex encircling the woody parts. The further examination requires some care.

Very valuable hints respecting the histological examination of fibres are given by M. Vétillart in the work already cited. An abstract of his methods, revised by the author himself, is published in Christy's "New Commercial Plants," No. VI. (1882). These are methods for the microscopical and structural investigation of fibres. Although useful in determining the relative abundance of the fibre bundles and the length and character of the fibre cells, they are by no means sufficient to afford a complete idea of the value of the fibre. To do this it is necessary to adopt chemical tests and carry them out with the precision which necessarily attaches to scientific measurements. Messrs. Cross and Bevan have remarked that "systematic inquiry, based upon uniform method, must contribute more than anything to the scientific development of a subject." We cannot do better than recommend for general use the more elaborate method found so successful by these original investigators. The Cross and Bevan method of chemically investigating vegetable fibres is fully explained in "Cellulose," part. iii., pp. 242-310. It is admitted that a microscopical examination is necessary also. A review of the structure and anatomy of exogenous and endogenous plants must therefore precede, or at least accompany, the chemical investigation.

Botanical Investigation.

The distribution of the fibre bundles in the plant itself having been ascertained, the next point is to extract the fibre by mechanical or chemical means, and have it carefully washed and dried. A fibre thus extracted would consist of numerous threads, each of which would represent a fibre bundle or filament, and form the unit for spinning purposes. The general appearance of the fibre in this state, the softness and fineness of the filaments, their strength, colour, and lustre, are at once appreciated. If the fibre is entirely new, the further examination necessary would be under the microscope. It would be useful, for this purpose, to have both a dissecting microscope, with a lens magnifying 10 to 15 diameters, and a compound microscope, with lenses magnifying up to 300 diameters. The eye-piece of the latter should be fitted with a micrometer. The reagents necessary would be a solution of iodine, sulphuric acid, glycerine, carbonate of soda, and caustic potash. The first point is to determine the number of fibre cells to each bundle, and the nature of the surrounding tissue. In some few cases the cells may be single, or in groups of two or three; in others, they may be in bundles of 30 to 50, more or less agglutinated together. A cross-section would also show the size or shape of the cavity of each cell, the thickness of the cell wall, and the characteristic markings—such as concentric rings, if any—present. Each cell should now be carefully isolated. Its length, as already mentioned, is of great importance. The operation of measuring should therefore be repeated, according to the degree of approximation required. The extreme, as well as the

average length, should be duly noted. The diameter of the cell is of less importance, but is also necessary.

Chemical Investigation.

The aim of a chemical investigation of fibres should be to determine the quantity and quality of the cellulose and its chemical characteristics. These are of primary importance. Other points are subsequently investigated, and on the total results thus obtained are based the appreciation of the fibre and its possibilities as an article of commerce.

The points to be dealt with are as follows :—

1. *Moisture.*—This is the water of condition or the hygroscopic moisture taken up by a fibre after being dried at a temperature of 110°. Textile fibres of the highest class are distinguished by their relatively low moisture. It might be mentioned that dry wood-pulp in commerce contains, in an ordinary atmosphere, 10 per cent. of hygroscopic moisture.

2. *Mineral constituent.*—This is the per-centage of ash left after burning the fibre. The lower the per-centage the purer the cellulose.

3. *Hydrolysis.*—This is a bleaching process, in which one portion of the fibre (*a*) is boiled in an alkaline solution for five minutes. The loss of weight shows the proportion of the fibre which yields to the solvent action of the alkali. Another portion of the fibre (*b*) is boiled for one hour. The loss of weight in the latter case gives the "degrading" action of the alkali.

4. *Cellulose.*—A specimen of fibre having been boiled in dilute alkali, as indicated above, is well washed, and exposed for an hour, at the ordinary temperature, to an atmosphere of chlorine gas. "It is then removed, washed, and treated with a solution of sodium sulphite, which is slowly raised to the boil. After two or three minutes' boiling, it is washed, dried, and weighed." The per-centage yield of cellulose, on the raw fibre, thus obtained, is the most important criterion of its composition and value.

5. *Mercerising.*—This shows the action of concentrated solutions of alkalis upon vegetable fibres. This was first studied by Mercer, hence known under his name. The action is noted in regard to the loss of weight sustained.

6. *Nitration.*—Fibres exposed to the influence of a nitrating acid (a mixture of equal volumes of concentrated nitric and sulphuric acids) increase in weight. They also acquire various colours. The net increase in weight varies from 5 to 55 per cent.

7. *Carbon per-centages.*—Accepting cotton as typical cellulose, the amount of carbon obtained by ignition is 44·4 per cent. The lower carbon per-centages are from 40-43; the higher, 45 to 50.

8. *Acid purification.*—To clean the fibre, and remove all accidental impurities, it is heated to boiling point in a 20 per cent. solution of acetic acid. It is then dried and weighed. The loss in weight sustained shows the impurities present.

I. SEED-HAIRS.

From the morphological point of view the fibres of commerce may be either seed hairs, the bast fibres from the inner bark of Dicotyledons or the fibro-vascular bundles from the stems, petioles, or leaves of Monocotyledons. On the other hand there is also a commercial classification. In this the various fibres are grouped as follows :—(1) the higher textiles, such as cotton, flax, common hemp, Sunn hemp, and China grass ; (2) the lower textiles, such as jute, Abutilon hemp, and Deccan hemp ; (3) white rope fibres, such as Manila hemp, Sisal hemp, Mauritius hemp, and New Zealand Phormium ; (4) brush and mat fibres, such as coir, piassava, kittool, and other palm fibres ; (5) paper materials, such as esparto and wood pulp.

In the present lecture we shall confine our attention to the fibres of the Dicotyledons, embracing what are known as the higher and lower textiles, composed of (1) Seed-hairs, and (2) Bast fibres from the cortical layers of the green stems.

Cotton.

The chief, and indeed the only commercial fibre from seed-hairs, used in this country, is cotton. This consists of the delicate, tubular, hair-like cells clothing the seeds. The commercial value depends on the length and tenacity of these hairs or "the staple." The plants yielding cotton are amongst the most important in the vegetable kingdom. The use of cotton dates from prehistoric times. Sanscrit records carry it back at least 2,600 years, while in Peruvian sepulchres cotton cloth and seeds have been found. The value of the cotton manufacture of the United Kingdom exceeds £130,000,000 sterling.

The cotton plant belongs to the Mallow family. Three species are generally recognised.

1. The Tree Cotton (*Gossypium arboreum*).—A small tree or shrub with red flowers; not cultivated, usually, for cotton, but a variety is said to yield the "Nurma" cotton of India.

2. American Cotton (*G. barbadense*).—In this species the seeds are readily separable from the cotton or investing hairs. The produce is regarded as the most valuable of any, and is known as Barbados, Bourbon, Upland Georgia, and other short-stapled cottons. A variety (*G. maritimum*) yields Sea-island cotton, also Egyptian cotton, and a form of the latter, called Bahmia cotton. *G. acuminata* yields Peruvian or Brazilian cotton, sometimes called "kidney cotton" from the shape of the seeds. *G. barbadense* is the chief cotton plant of many parts of Africa, and the much prized "Dharwar" cotton of India. Of the world's supply of cotton the United States contribute about 56 per cent., though according to official statistics published in America it is estimated at not less than 70 per cent. The average number of acres under cultivation in cotton from 1880 to 1889 was 17,731,172; the average yield per acre was 168 pounds; while the average price per acre to the farmer was 8·8 cents. In the previous ten years, from 1870 to 1879, the average yield per acre was 191 pounds, while the average price to the farmer per acre was 12·8 cents. Hence it may be inferred that the productive power of the cotton lands in the Southern United States has declined of late years, as also the profit to the farmer.

3. Asiatic Cotton (*G. herbaceum*).—The cotton is not so readily separable from the seeds. This and its varieties and hybrids, too numerous to mention, yield the chief cottons of India, such as Surat, Madras, and Bengal cottons. The plant is common in the Mediterranean region and every part of tropical Africa. It can be cultivated in colder countries than *G. barbadense*. A Chinese variety yields Nankin cotton, which is of a tawny colour. The total area in cultivation under cotton in British India in 1892-93 was nearly 9,000,000 acres. The largest areas were in Madras, Berar, Bombay, and the North-West Provinces. The highest exports during the last five years took place in 1889-90, when cotton to the value of 187,000,000 rupees was shipped from India. The export in 1892-93 was slightly less being of the value of 127,000,000 rupees. Besides cotton there was exported from India cotton seed in 1888-89 to the value of 301,577 rupees; in 1892-93 this had fallen to a value of 61,708 rupees.

As regards the industrial application of the various kinds of cotton, the following is a brief summary:—

Sea-island and Egyptian cottons are chiefly employed for fine muslins and laces; Brazilian and ordinary American, for cambrics and calicoes; inferior American and Indian, for fustian and heavy fabrics.

Further particulars of a useful character, on cotton: its cultivation, production, distribution, and consumption, may be obtained from the article, "Cotton," in "Chambers' Encyclopædia," iii., pp. 507-516. The present year is remarkable for the unusually low prices obtained for all kinds of cotton. Good, fair Bengal was selling, on the 25th March last, at $2\frac{1}{4}$d. per pound, good ordinary American, at $3\frac{1}{16}$d. per pound, while even the best Egyptian realised only $5\frac{9}{16}$d. per pound. As a result, many cotton-producing countries are reducing the area of cultivation, and directing attention to other products.

Kapok and Vegetable Silks.

Kapok is the Dutch name for the seed-hairs of the white silk-cotton tree of the East Indies (*Eriodendron anfractuosum*). The kapok of Java is regarded as the best. It is, however, too short in the staple, too smooth, and too soft to be spun into yarn. Its chief use is for stuffing pillows, mattresses, and sofas, where its lightness, insusceptibility to moths, softness, and elasticity render it superior to all but the best qualities of feathers, wool, and hair.

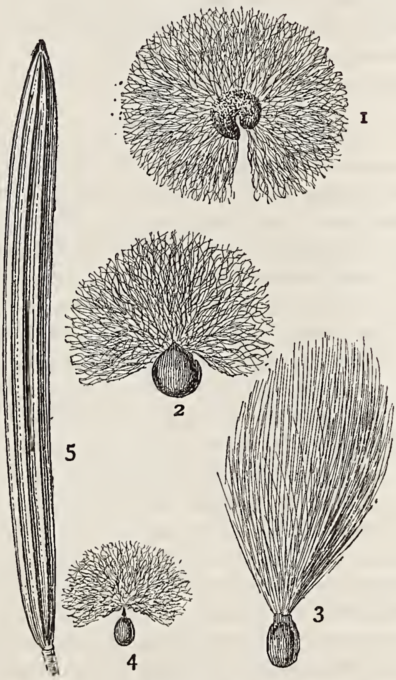
The floss from the red silk-cotton tree, *Bombax malabaricum*, known in India as *Semal*, is regarded as inferior to that obtained from the white silk-cotton tree. The principal market for kapok is Holland. In 1885 Java exported 600,269 kilos of kapok. In the West Indies both *Eriodendron anfractuosum* and *Bombax ceiba* are known as silk-cotton trees. It was recommended by the writer, in 1884, to export silk-cotton from Jamaica, where, at a low estimate, about 3,000 bales could be gathered every year.

The Down-tree (*Ochroma lagopus*) of tropical America, especially Jamaica, belongs to the same natural order as the silk-cotton trees. The pod is long, and channelled longitudinally. The silken down which envelops the seeds is of a rich fawn colour, and very soft and elastic. It is used, locally, for stuffing beds. As the tree grows very fast, the down might be readily produced in large quantities.

Macfadyen says "there is no doubt it could be made into cloth, and employed in hat-making."

The silky cotton of *Cochlospermum Gossypium*, sometimes known in India as the White Silk Cotton-tree, but entirely distinct from the tree above described under that name, has hitherto received little or no attention. The tree is common in the lower hills of India, and is often planted near temples. It has large, handsome, yellow flowers, and its pendulous, pear-shaped fruits ripen before the new leaves appear. The cotton is soft and silky, but very short. According to Dr. Watt it could be supplied at a much lower rate than the kapok, and has a resistance about it which prevents it from matting, like semal, when used in upholstery. This fibre has not yet been placed within reach of the European manufacturer. Its value is practically unknown.

Fig. 2.



Seed Hairs.

1. *Cochlospermum Gossypium*. 2. Kapok (*Eriodendron anfractuosum*. 3. Madar (*Calotropis gigantea*). 4. Down tree (*Ochroma lagopus*). 5. Fruit of do. (reduced).

Vegetable Silks.—Many plants belonging to different natural orders yield silky hairs, usually straight, forming a coma, or tuft at the apex of the seeds. Few of these have hitherto been investigated. The most familiar is that of the "madar" or "yercum" (*Calotropis gigantea*), or of the closely allied species (*C. procera*). The natives of India "regard the madar silk hairs as much cooler than semal, or red silk-cotton, and affirm that they have a soothing effect when used in pillows." As the plant will thrive in waste, and almost sterile and dry tracts of India, it would not be difficult to produce the silk hairs in any quantity. So far, however, it is nowhere cultivated. It is widely distributed in both the Old and New World tropics. In the West Indies it is known as French cotton, and the floss is used for making fans. Dr. Watt states that owing to the attention drawn to this fibre at the Colonial and Indian Exhibition, 1886, "it has been found possible to utilise it by mechanically drawing it in with cotton in the preparation of fans." To overcome the difficulty of procuring a uniform supply it was proposed to attempt to cultivate the plant on a large scale. "It may thus be hoped that madar fibre may at last be viewed as an established new industry, that will greatly benefit the poor cultivators of a large tract of the less productive portions of India."

A noted vegetable silk is yielded by *Beaumontia grandiflora*, an extensive climber in East and North Bengal, with large showy flowers. It is cultivated in gardens for ornament. The seed-hairs are said to be the best yet known though least utilised. Specimens are in the Kew Museum. The fibre is very lustrous and purely white. It also possesses a remarkable degree of strength. The hairs are easily separated from the seeds, and are usually more than inch and a half long.

In the Argentine the silky hairs obtained from a plant, known locally as the "yachan" (*Chorisia insignis*), is used for a singular purpose by the Mataco Indians. These people make a netted cuirass from the fibre of a wild pineapple (*Bromelia serra*). This is padded before and behind with the silk hairs of the yachan. In order to make it impervious to the arrows of their enemies, the Indians roll themselves in water, until the fibre swells into a felted mass. The singular property possessed by this fibre could no doubt be utilised for other purposes.

(*To be continued.*)

Miscellaneous.

CEDAR AND CORK FORESTS OF ALGERIA.

The Government of Algeria has recently been taking steps to direct public attention to the forests of the colony, especially to those of the cedar and

cork oak. It has published two *brochures* on the subject, which, Consul Playfair says, are beautifully illustrated, and contain much useful information. The first of these treats of one of the most attractive features of the mountainous regions in the department of Algiers and Constantine, a never failing source of interest and pleasure to the traveller, but hitherto of no great commercial importance. The cedar is a variety of that of Lebanon, and it occurs at an altitude of from 4,000 to 6,000 feet above the level of the sea in the Aurès Mountains; in the Belezma, near Batna; at Ben Thaleb, south of Setif; in Babor and Ta Babort, between Bougie and Djidjelby, in which locality it is associated with a magnificent conifer, peculiar to Algeria, the Atlantic Pinsappo. In the department of Algiers it is found in the Djurdjura range; on the hills above Blida; in the Ouransenis, and at Teniet-el-Ahd. Many Alpine plants are associated with it, such as the Taxus, Ilex, Juniperus, and Rhamus, various species of oak, and flowers of great beauty. The forest of Teniet-el-Ahd, being easy of access, was treated in the most ruthless manner by the military in bygone days, before the Forest Department was properly organised. Trees were cut down, and allowed to perish on the spot. Dead wood and dry grass produced fires which threatened the very existence of the forest, and the Arabs were in the habit of burning the old grass to produce fresh pasturage for their flocks. Now the utmost care is taken of this forest, and its regeneration is rapidly taking place. Young trees are everywhere springing up, and though wood of average dimensions is still insufficient, that is a want which will disappear in time. The ruinous system of granting forest concessions which formerly existed, has ceased; the trees are now felled by the Forest Department, and the timber is sold by public auction. The quantity disposed of in 1894 amounted to 10,983 cubic metres, valued at 42,000 francs (£1,680).

Cedar wood is said to be somewhat less enduring and elastic than pine from the north of Europe, and therefore requires a rather larger scantling when used for architectural purposes; but these objections have been found to exist more especially in timber containing the heart of the tree. Its nature is now better known than it used to be; the heart is generally used for railway sleepers, and the outside portions for carpentery. Sleepers thus made have been know to last from eight to ten years; this wood has also been used with good results for paving purposes and for shingles. It is, however, especially for cabinet making and decorative purposes that cedar wood is most valuable, and for such purposes it is advisable to saw the wood so as to get rid of the heart altogether, and to cut up the outside portion so as best to display its beautiful and irregular veining. The forest of Teniet-el-Ahd has an area of 2,325 acres, and it contains a considerable number of trees that might fairly be used, some of the trees being of incomparable beauty and incalculable artistic value. This forest is a favourite resort of travellers, and the Government is resolved to work it only in the most legitimate manner by a system of rotation, so as not to destroy its great beauty. The means at present employed of felling the trees and cutting up the timber by hand is too expensive; there is not sufficient water power to drive a saw-mill, and there is no other resource but to have steam-power; till that is done, and means of communication are improved, the cedar forests are not expected to prove remunerative. The amount of timber available in the various forests is said to be so great, that when these difficulties are overcome, it will be a source of considerable wealth to the colony.

As regards the cork forests, in that of Constantine the cork oak is limited to the region of the Tell, comprised between the sea-coast and a line passing by Akbou, Karrata, Smendou Bordj, Sabbat, Guelma, and Souk Ahras, containing an area of about 1,600,000 hectares (4,000,000 acres). Of the 281,402 hectares of cork oak possessed by the State, 231,690, or nearly nine-tenths of the total, are in the department of Constantine. The State has given up farming out these forests, and even selling the cork on the tree, as used formerly to be done. They are now entirely worked by the Forest Department, which sells the produce in the open market. Cork trees are considered workable when they have a diameter of ·025 to ·027 of a metre, including the crust of bark; they attain these dimensions in from six to fifteen years. When all the forests throughout the department are in full production, it is calculated that the total yield will amount to 200,000 metric quintals (metric quintal = 520½ lbs.) of cork. As, however, the preservation and improvement of the forests has only recently been seriously undertaken, the present produce is very small, not more than 8,000 quintals. As has been said, the area of State forests in the department of Constantine is 231,690 hectares, an amount equal to the aggregate of those of Spain and Portugal; it is evident therefore that Algeria will soon become the principal cork-producing country in the world. The sale of cork usually takes place between the 1st and 30th September, so as to enable purchasers to remove it before the rainy season sets in. As the cork forests in the departments of Algiers and Oran are much less considerable in extent, no special remarks are necessary regarding them. The revenue derived from cork forests during 1894 amounted to 388,400 francs (£15,500). Forest fires in the department of Constantine were more destructive than usual at the end of 1894. A revision of the forest laws has been prepared by the Government, but it has not yet been presented to the Chamber. It is stated that if things go on as they have been doing, more especially in 1894, there may soon be no forests to protect. A cork tree unless it be protected by at least five years growth of bark, even if not actually burnt, is certainly killed by the heat of a great conflagration.

MEMORANDUM ON THE BRITISH ASSOCIATION SCREW GAUGE FOR SMALL SCREWS.

By R. E. Crompton, M.Inst.C.E., Pres.Inst.E.E.*

As a result of the two reports presented by the committee appointed by the British Association to design a standard screw gauge for small screws, a large number of users, including H.M. Post-office, have adopted them.† In 1890 the London Chamber of Commerce appointed a committee to forward the question of making the British Association screw gauge universal among electrical manufacturers, and a circular was sent round to the entire electrical manufacturing trade, with the result that with hardly any exceptions the whole trade promised to adopt the screws, and thus ensure the extremely desirable result of making all the same screws used in electrical apparatus interchangeable. It is, however, much to be regretted that a considerable number of users of small screws (the principal offenders having their works in Birmingham) are still using other gauges, and thus complete uniformity has not been obtained up to the present time. One great difficulty in this matter has been that of obtaining standard gauges which could be referred to in specifications or orders for such screws. Wherever it is desired that the screws should be thoroughly interchangeable it is necessary in such specifications to have a paragraph somewhat as follows:—

"Testing. Each box of screws will be tested as follows:—A handful of one dozen screws will be selected at random from each box; these will be tested both as to the screw portion and the plain portion of the shank by being respectively screwed or pressed through the corresponding maximum and minimum gauge holes in the standard plates supplied on loan with the order, and which must be returned with the finished screws. Any screw which cannot be screwed or pressed by hand into the maximum female gauge, or which can be screwed or pressed by hand without forcing into the minimum gauge, will be rejected. If more than one screw in each dozen thus tested is so rejected the whole box will be returned to the contractors."

Four years ago I found it necessary to have standard plates made for the purpose of ordering screws to the above specification. I had a number of such plates prepared, but found the very greatest difficulty in getting them made so that they would fulfil their required duty, the makers giving as an excuse that there was no standard B.A. gauge then existing to which they could refer. This difficulty can only be removed by a complete set of standards being made and deposited either with the Board of Trade or at the Society of Arts, or with a similar central institution; and it is highly desirable that the British Association should either call together the surviving members of the original committee or form a new committee to consider the question of making up these standard gauges and deciding on the place where they are to be deposited.

One question for the committee would be the requisite allowance of clearance between the absolute diameters of the various sizes as laid down in the report of the committee and the sizes of the maximum and minimum gauge holes in the gauge plates.

Another point of importance in order to make this standard screw gauge universal would be the issue of a short descriptive report, with illustrations, giving the sizes, clearances in gauge plates, best method of reproduction on English lathes of these screws, together with a few sectional drawings showing the shape of thread, rounding off, &c.

* Read before Section G of the British Association Meeting at Ipswich.

† These reports are printed in the *Journal*, vol. xxxi. p. 115; vol. xxxii., p. 1026.

General Notes.

Bulgarian Railway Development.—In 1892 the Bulgarian Government, according to Consul Stephan, contracted with the Austrian Land Bank for a loan of 125,000,000 francs (£5,000,000 sterling) for the completion of the railway system in the principality, and for the construction of new harbours at Varna and Bougas. It has now been decided by the Council of Ministers to begin the construction of the following lines:—(1) Sofia-Roman, a distance of 68 miles, at a cost of £880,000; (2) Roman–Plevna–Polikranishte–Shumla, 207 miles, at a cost of £1,000,000; (3) Polikranishte–Tirnovo–Nova–Zagora, 68 miles, at a cost of £660,000; (4) Polikranishte–Roustchauk, 65 miles, at a cost of £380,000; (5) Gabrovo–Selvi, to a point on the central line, 43 miles, at a cost of £24,000. In addition to these, the following lines have been proposed, and will be built soon after the completion of the above-named lines:—(1) Pernik, south, to the Turkish frontier, 49 miles; (2) Mesdra–Wratza–Widdin, 80 miles, at a cost of £338,000; (3) Philippopolis–Karlofev–Kasanlyk-Nicolaevo, 86 miles, at a cost of £305,000.

Deodorising of Sewage by the Hermite Process.*—This process consists of passing an electric current obtained from a dynamo through sea water, or a solution containing magnesium and sodium chlorides, whereby a portion of the chlorides is converted into hypochlorite, a substance which disinfects, deodorises, and bleaches similar to the active ingredient of bleaching powder, viz., calcium hypochlorite. This solution is called the electrolysed or hermite solution, and may contain from half to one gramme of active chlorine per litre. The author described the deodorising effects of the electrolysed or (hermite) solution on sewage, especially upon that in the main sewer of Ipswich, and gave the results of trials made in August and September, 1894, and in June, July, and August of this year.

* Abstract of paper read by J. Napier, F.C.S., before Section G of British Association meeting at Ipswich.

Journal of the Society of Arts.

No. 2,237. Vol. XLIII.

FRIDAY, OCTOBER 4, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

COMMERCIAL FIBRES.

By Dr. Morris, C.M.G., M.A., D.Sc., F.L S.,

Assistant-Director of the Royal Gardens, Kew.

Lecture I.—Delivered March 18, 1895.

[Continued from page 898.]

II. BAST FIBRES.

The most familiar of bast fibres is the coarse reticulated bast of the lime tree, used for making Archangel mats. This is obtained from the inner bark. In other plants, such as flax and China grass, similar bast fibre is capable (as will be shown later) of being divided into fine, silky filaments, with strength, flexibility, and lustre almost equalling the finest silk.

The various bast fibres here enumerated are arranged in accordance with what is believed to be their intrinsic value.

Flax.

Flax, commercially, is the most important textile fibre next to cotton. It has been cultivated from remote antiquity. The plant (*Linum usitatissimum*) is an annual. The area of cultivation is world-wide, but chiefly in the temperate zone. The most suitable localities are belts of coast-land, subject to the moisture-laden winds from the sea. The value of the flax and tow imported into the United Kingdom, in 1893, was £1,104,851 sterling, chiefly from Russia. The other flax-producing countries are Germany, Austria, Italy, France, and Belgium. The Belgian flax is unequalled for quality. In the United Kingdom there are only 10,000 acres under flax. Large areas are cultivated in the United States, Canada, and British India, but almost entirely for seed purposes. Over 2,000,000 quarters of seed for oil and oil-cake purposes are annually imported into this country. A white linseed, in India, yields 45 per cent. of oil of a very light colour. The fibre of flax is extracted solely by retting the stems with dew or in water. Then follow the "breaking" and "scutching," which consist in beating and shaking the broken flax in order to free it from loose and useless particles. All these are usually undertaken by the cultivator.

It is generally admitted that a new source of supply for flax, or at least a good substitute for it, is a desideratum in English manufacture. This may lead, eventually, to the commercial utilisation of China grass or ramie.

Good flax fibre consists of 80 per cent. of cellulose. The ultimate cells are 25-40 mm. long (about 1½ to 2 inches). In these two important characteristics flax is practically at the head of commercial fibres.

Remarks.—The bast layer in flax is in a continuous ring; sometimes two concentric fibrous zones are developed; the fibres with different features in each. The fibre bundles contain 5 to 10 cells or filaments, which are easily sub-divided. The cells, as already stated, are 25-40 mm. long. The normal have a small diameter, are thick walled and polygonal. The others are ovoid, with a large cavity resembling ramie.*

Hemp.

The term hemp is often used in a generic sense, and is applied to fibres derived from entirely different plants. Sunn-hemp is yielded by a species of *Crotalaria*, Manila hemp by a wild plaintain, Sisal hemp by an aloe (*Agave*), while "Chinese hemp" is applied indiscriminately to the fibre of an *Abutilon*, pineapple, China grass, as well as to the common hemp. The latter is the fibre of an annual (*Cannabis sativa*) closely allied to the hop-plant. Hemp is largely cultivated in Central and South Russia, Hungary, Germany, France, and Italy. Italian hemp is regarded as the best. In India hemp is cultivated solely for the narcotic resin yielded by the leaves and flowers. The dried leaves are known as "bang," while the dried flowers are called "gunjah." Both of these, as well as the gum-resin itself, are used for smoking. The characters of Indian hemp fibre, explanatory of the fact that it is useless for commercial purposes, are fully discussed by Vétillart, pp. 72-75. In temperate countries the fibre yielded by the male hemp plants is tougher and better than from the female plants. The male plants are

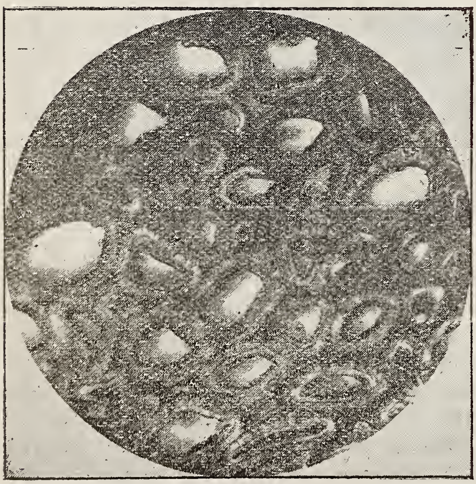
* Unless otherwise stated the information in this and subsequent remarks is based on "Indian Fibres," by Messrs. Cross and Bevan.

gathered first, while the female plants are collected a month later. The extraction of hemp fibre is effected by means of retting, and breaking, and scutching, as in flax. Hemp ropes are very durable, and possess great strength and elasticity. In the Kew Museum is a portion of the cable of the *Royal George*, sunk at Spithead in 1782, and samples of paper made from it. Owing to the number of fibres, not real hemp, mixed together in the Customs' returns, it is impossible to give those for common hemp alone.

Madar Fibre.

Madar (*Calotropis gigantea*), already mentioned as yielding silky seed-hairs, also yields, from the inner bark of the young shoots and branches, a very valuable fibre. Dr. Watt speaks of it as one of the strongest and finest of vegetable fibres, and one of the most beautiful. By nitrating the fibre, under chemical treatment, a substance was produced by Cross and Bevan which could be scarcely distinguished from silk. The high expectations raised in regard to this fibre have not, so far, been realised; but, as the plant will grow in the poorest soils, and requires little cultivation, its double products of bast-fibre and floss deserve the fullest investigation.

Fig. 3.



Madar (*Calotropis gigantea*).*

Section through a portion of the bast region. The fibre cells are oval, with thick walls, loosely cohering together, and possessing characteristic markings. × 300.

* This, and similar illustrations, are from photo-micrographs by Mr. John Christie, F.R.M.S., of 72, Mark-lane, E.C. Both Mr. Christie's intimate knowledge of commercial fibres, and his large and varied collection of preparations relating to them have been very generously contributed enhance the value of these lectures.

Remarks.—In the plant the fibre bundles are disposed in aggregates of 50 to 100. The cells are oval, loosely coherent. The bundles are usually in short lengths, 8-16 inches, owing to the nodes of the stem. The filaments, or cells, are 10 to 30 mm. long, ends tapering.

Rajmahal Hemp.

A large twining shrub (*Marsdenia tenacissima*), found in Northern India, is remarkable as yielding "one of the strongest and best fibres known in India." It is next to ramie in point of fineness and durability. If this plant could be cultivated for its fibre, it would become most valuable. Little, however, has been done in this direction since the days of Roxburgh. In point of intrinsic merit, Rajmahal hemp stands in the first rank of textile fibres. It is, however, quite unknown in commerce. Its merits are well set forth in Watt's "Dictionary of the Economic Products of India," V., pp. 188-190.

Remarks.—The fibre bundles are 10 to 15 inches long, with 10 to 30 cells in the bundle. The cells are 5 to 20 mm. in length.

China Grass, Ramie, or Rhea.

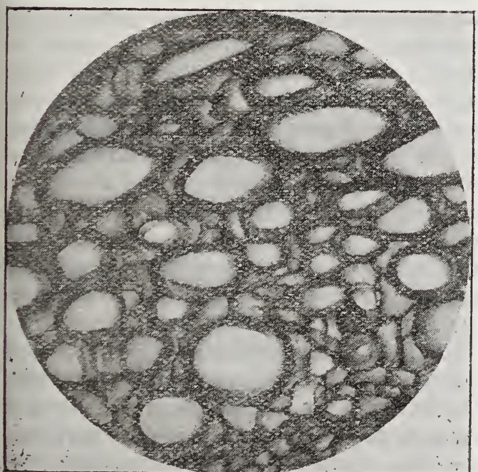
China grass (*Bœhmeria nivea*).—This is a shrubby plant with the habit of the common nettle, but without stinging hairs. There are numerous straight shoots that arise from the perennial rootstalk to a height of 4 to 6 feet. The leaves are on long petioles, broadly heart-shaped, with serrated edges and white downy beneath. The seeds are small, and produced somewhat sparingly. This is the original China grass plant so long cultivated by the Chinese under the name of *Tchou Ma*. It grows moderately well in the south of England, and if the roots are covered in winter, they produce good crops of shoots that are fit to cut in September. In warmer countries China grass flourishes with great vigour. It is now distributed in most tropical and subtropical countries. The China grass fibre usually received in this country has been cleaned by the Chinese by hand. The supply is limited, and no large industry can be sustained by this hand-cleaned fibre alone. When carefully prepared and purified by chemical processes, China grass is pre-eminent amongst vegetable fibres for strength, fineness, and lustre. For more than fifty years it has been sought to cultivate the plant and to extract the fibre on a commercial scale. China grass is still, however, in the stage of expectancy. Many inventors claim that they have

succeeded in solving the problems connected with it, but no one has yet so thoroughly established his claim as to induce extensive areas to be planted with China grass in any part of the world. Purely experimental plots are common everywhere.

There are two forms of this plant. One is the China grass mentioned above, a temperate, and the other ramie or rhea, a tropical plant, known as *Boehmeria nivea*, var. *tenacissima*. It would be well to preserve these distinctions in regard to the fibre also. The term ramie, or rhea, should only be applied to the variety *tenacissima*. This differs from the type by its more robust habit and larger leaves, which are green on both sides. This character easily distinguishes it from China grass, which has leaves white-felted beneath. The distinction here suggested is an important one. Ramie or rhea is a native of Assam and the Malay Islands. It thrives only in tropical countries, and it is useless to cultivate it elsewhere.

At Kew it has been found that while ramie or rhea (*B. nivea*, var. *tenacissima*) cannot be grown in the open air, the China grass (*B. nivea*) remains in the ground all the winter, and furnishes a good crop of shoots, but only once in the year.

FIG. 4.



CHINA GRASS (*Boehmeria nivea*).

Transverse section × 150. The fibre cells are round or oval, with moderately thick walls and large cavities.

The value of the ramie, or rhea fibre, as compared with China grass, has not been carefully and fully investigated. Ramie from India has, however, not proved so valuable, so far, as the China grass. In the large mass of literature on China grass there is considerable confusion between it and ramie or rhea, and the results in consequence lose their value.

Remarks.—In the plant the bast is a continuous ring, with the cells in loose contact. In a cross-section the latter appear ovoid to polygonal, with a large cavity; they are, however, very variable. The mean diameter is greater than in flax. The fibre bundles are usually three in number, frequently single. The cells are of exceptional length, 40 to 200 mm. ($1\frac{1}{2}$ to 10 inches). This is greatly in excess of any known fibre.

Cultivation.—Our knowledge of the cultivation of China grass is derived from the Chinese. It can be propagated either by seed or offshoots. Where seed is used, nursery beds carefully prepared, supplied with rich soil, and regularly watered are essential. Care should be taken to mix the fine small seeds of the China grass with soil, and sow lightly on the surface of the ground. The plants raised in these beds may afterwards be transplanted, and put out at distances varying from $1\frac{1}{2}$ to 2 feet apart, according to the nature of the soil; the better the soil the further apart the plants; and, conversely, the poorer the soil the closer the plants. Clay soils appear to be quite unfit for the cultivation of China grass, and hence these, as also very light, poor, gravelly soils should be avoided. The latter may, of course, be improved by abundant and regular supplies of manure, but the cost of cultivating China grass on such soils would render it prohibitive as an article of export.

When off-shoots or suckers can be obtained, they are to be preferred to seeds, as being more expeditious, and yielding better results. When off-shoots or suckers cannot be obtained in sufficient numbers, young plants may be obtained by "layering" the taller stems, that is, bending them down (without breaking) close to the ground, and covering the joints with soil. From every ripe joint plants will be produced.

The burden of the treatment of the China grass, in all its stages, by the Chinese, is the plentiful use of manure and water. Unless the soil is naturally rich and moist, the cultivators of China grass must be prepared to supply their plants largely with manure, and keep them in a moist, vigorous, perpetual state of growth.

Cutting the Stems.—The shoots are fit to cut when the bark is of a brown colour for about six inches from the roots. In the pro-

cess of cutting, the young shoots springing from the rootstalk should not be injured, as they would form the succeeding crop. When once the China grass plants are established, the stems are produced more abundantly with age, and also grow much faster. Where too thick they should be carefully thinned so as to promote the growth of large healthy unbranched stems. The duration of life of the root depends on the strength and character of the soil, the relative quantity of manure supplied, the amount of moisture present, as well as on the general cultural treatment received by it. There is no reason to doubt that where favourable conditions exist a plantation of China grass will last for many years (ten or twelve), and prove very productive.

The above remarks on the cultivation and cutting of China grass apply equally well to ramie or rhea.

Extracting the Fibre.—In January, 1870, the Government of India was so impressed with the value of ramie or rhea as a commercial fibre that it offered a prize of £5,000 for a machine or process that would produce "a ton of fibre of a quality which should average in value not less than £50 in the English market," at a total cost (all processes of manufacture and allowance for wear and tear included) of not more than £15 per ton. A trial of machinery took place at Saharunpur in August, 1872. The prize was not awarded. A donation was however given to one machine, which produced an inferior fibre worth but £18 per ton, and fit only for cordage. In 1877 the offer of a prize was renewed and a further trial took place in September, 1879. The results were equally inconclusive. This offer of a prize by the Government of India was definitely withdrawn in 1881. Since 1881 numerous efforts have been made to devise means for extracting the fibre. A process that had some success was the Favier-Fremy process, in which the stalks were steamed and the ribbons or strips were afterwards cleaned by chemical means. In 1888 there took place the first of the International competitions held in Paris. The results are given in the "Kew Bulletin," 1888, pp. 273-280. Two machines received a gratuity only. The trials were renewed in connection with the Paris Exposition Universelle in 1889. A report of these is given in the "Kew Bulletin," 1889, pp. 258-278. First prizes were awarded to Mons. P. A. Favier, Société le Ramiè Française, for a mechanical process with rollers, and to Mons. Norbert de Landtsheer, for a machine with a drum and beaters. The former cleaned at the rate of 443 lbs. and the latter at the rate of 575 lbs. of dry ribbons per day of ten hours, from green stems without leaves. A second prize was awarded to MM. Ch. Crozat de Fleury et A. Moriceau, for a process for steaming the green stems in the fields, and peeling the ribbons by hand. The Favier mechanical process has since been used to extract fibre in France and Spain on a moderately large scale. It is, however, not available for general use, as the inventor prefers to keep it in his own hands.

In 1891, a third series of trials was held at Paris under the auspices of la Société des Agriculture de France. The results were promising, but no practical advance was made on those reported for 1889. In America trials were held at New Orleans under the auspices of the Department of Agriculture, Washington, in 1892 ("Kew Bulletin," 1892, pp. 304-306). These were renewed in October, 1894, and a detailed account is given in the "Bulletin" of the Experimental Stations of Lousiana, No. 32, 1895. "Two machines were entered for trial, one by the Textile Syndicate, 72, Finsbury-pavement, London, for green decortication, and the other by Samuel B. Allison, of New Orleans, for dry decortication." The committee stated: "We report great progress in ramie machines since our last test (in 1892), but neither of the machines are yet ready for successful operation on a small scale by farmers and planters." They added "the outlook is promising." There are several machines and processes now under experiment in this country, but no public trial has been attempted owing, probably, to the absence of sufficient material to operate upon. It is obvious that such trials can only be properly carried on where there are large areas planted, and where stems are available for continuous working.

Numerous articles have lately appeared respecting a revival of interest in ramie. There is no doubt a large amount of money is being spent in the endeavour to solve the ramie question. Quite recently it was claimed that "the treatment of ramie can now be carried on upon lines that will enable it to take its place among the other textiles . . . . inferior only to silk in point of 'number' or fineness."

What may be regarded as a distinct advance has been made in the treatment of raw ramie ribbons by the Forbes process, now under trial in this country. The filasse produced by this process, forwarded to the Kew Museum, is of exceptional quality. From the Boyle Fibre

Syndicate there has been received, for the first time, a complete set of samples of ramie goods manufactured in this country. The yarn was spun at the Long Eaton Mills in Derbyshire. These are quite equal to the best French manufacture. A very complete series of these and similar articles may be seen in the Kew Museum I., Ground Floor, Case 103.

In order to understand the special character of the China grass, or ramie industry, it is desirable to enumerate the different stages connected with it. In the first place, we have the mere business of cultivating the plant, and of producing stems containing the fibre in the best possible condition. This is purely the work of the planter. Secondly, we have the process or processes necessary to separate the fibre from the stems in the form of ribbons and filasse. It is necessary, for many reasons, that this should be done, either by the planter on the spot, or by a central factory close at hand. Thirdly, we have the purely technical and manufacturing process, in which the filasse is taken up by the spinners, and utilised in the same manner as cotton, flax, and silk are utilised for the purpose of being woven into fabrics.

It may be mentioned that the cultivation of the plants presents no difficulty. They will grow rapidly enough, and, if highly cultivated, will produce two or three, or possibly more, cuttings each year. The chief difficulty is in devising means for extracting the fibre from the stems cheaply and expeditiously. The next stage for treating the ribbons chemically, and preparing a white "filasse," appears to be much more advanced.

Other Nettle Fibres.

Besides China grass and ramie there are many other nettle fibres obtainable from Indian plants that are deserving of notice. It is pro. bable that some of these may be even better than ramie, or at least more readily available for cultivation in certain parts of India. A brief enumeration of the plants yielding these nettle fibres is all that is possible within the limits of these lectures.

Tashiari (*Debregeasia hypoleuca*).—A large shrub forming dense undergrowths in the Himalayas. The branches and leaves are clothed with a snow-white wool. The fibre is extracted by boiling the stalks in water and wood-ashes. The fibre is afterwards washed, sprinkled with the flour of *Paspalum scrobiculatum*, and left to dry. It is then ready for spinning. In some parts of India this fibre, on account of its strength, is used for bow-strings.

Nilgiri Nettle (*Girardina heterophylla*).—A stout tufted herb, rising to 6 feet in height. All parts are covered with stinging hairs. "The bark abounds in fine white glossy silk-like strong fibres" (Roxburgh). The stinging hairs are an obstacle to the utilisation of this fibre, but it is undoubtedly of great intrinsic value.

Poi (*Maoutia Puya*).—A shrubby nettle with leaves white beneath. Dr. Watt reports on this plant:—"Probably more easily cultivated than rhea, while the fibre would be found quite as serviceable."

Ban-rhea (*Villebrunea integrifolia*).—This "wild rhea" of Assam is said to yield a fibre stronger than either China grass or rhea. The plant is cultivated by the native tribes in north-east India, and from it they obtain "a fine fibre, admirably adapted for fishing lines and nets, and remarkable for its power of resisting moisture." It has been recommended to the Government of India to cultivate this plant, and investigate its merits side by side with China grass and rhea.

Ban-Surat (*Laportea crenulata*).—This is a wild nettle of India and Ceylon. It is an evergreen shrub growing in the interior hills, and clothed with stinging hairs. The stems yield a strong useful fibre, suitable for ropes and paper-making. Good specimens of the fibre are in the Kew Museum. A sample from Ceylon is labelled "Maoosa" fibre.

Besides these Indian nettles, a few plants, closely allied to them, have come into prominence in other parts of the world.—

Urera Fibre (*Urera tenax*).—A large shrubby or tree-like nettle of Natal, where the bark is highly prized by the natives for the sake of the fibre yielded by it. The fibre is made into thread or cord, and closely resembles China grass, but is rather more brittle, and not so lustrous. This is a comparatively new fibre, first described in the "Kew Bulletin," 1888, pp. 84-85, with a plate.

Mamaki (*Pipturus albidus*).—A shrubby nettle of the Pacific islands, especially the Hawaii archipelago. The bark is used for the manufacture of native cloth (similar to that prepared from the paper mulberry—*Broussonetia papyrifera*). Some fine specimens of fibre and cloth are in the Kew Museum.

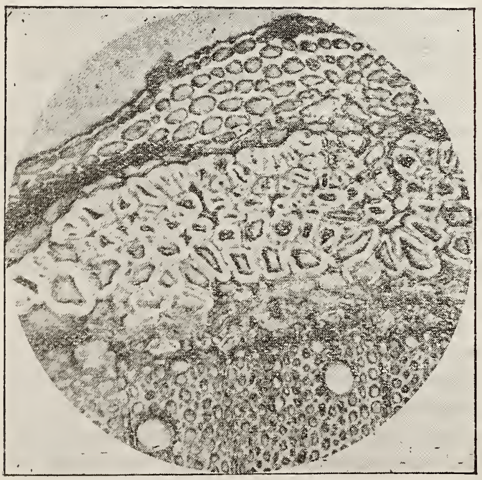
Rere (*Cypholobus macrocephalus*).—This is another shrubby nettle from the Pacific islands, but more widely distributed than the last. The fibre from the bark is made into white fine mats, which in Samoa are "a medium of ex-

change and a standard of wealth" amongst the native chiefs.

Sunn-hemp and Sida Fibre.

Sunn-hemp (*Crotalaria juncea*). — An annual shrub belonging to the Leguminous order, 6 to 10 feet high, with bright yellow flowers resembling those of the common broom. It is grown in western and southern India, over an area of 150,000 acres, for the sake of its fibre. This is known as Sunn-hemp, Bombay hemp, Madras hemp, and Jubalpur hemp. The stems after being cut are steeped in water until the bark is loosened. The latter is then taken in handfuls and beaten on the surface of the water until the fibrous part is separated and thoroughly washed. The fibre after being dried is cleaned and combed. Roxburgh and Royle showed beyond all doubt that Sunn-hemp was superior to jute, and this fact has since been confirmed. Dr. Watt states as his opinion, after carefully weighing the relative merits of Sunn-hemp and jute, "it is impossible to urge too strongly the claims of this much neglected fibre." London brokers state that the only difficulty in pushing the trade in Sunn-hemp is the inability to procure a uniform and large enough supply. If encouragement were given to the industry in Southern India it is confidently anticipated that the foundation would soon be laid for a textile industry that would bear creditable comparison with the jute trade of Bengal.

Fig. 5.



Sunn-hemp (*Crotalaria juncea*).

Section through stem. The uppermost tissue is the cortical parenchyma; next below is the bast region with fibre cells; lastly, comes the prosenchyma (woody tissue) with two large pitted vessels. Between the bast region and the wood is the cambium region. × 150.

Remarks.—The fibre bundles consist of 20 to 50 cells, not easily divided. Each cell is 3 to 5 mm. long with the ends tapering abruptly; polygonal in transverse section with a small cavity. The wall of the cell shows well marked concentric rings.

Sida hemp (*Sida rhombifolia*).—A very variable plant, widely distributed in tropical countries, with yellow or white flowers. It yields an excellent fibre, said to be better than jute, but, unlike jute, capable of cultivation over immense tracts of country. Sida fibre, from Queensland, exhibited at the Colonial and Indian Exhibition of 1866, gave great promise. Its superiority to jute was shown in the "uniformity, firmness, and divisibility of the fibre bundles, and in the softness and colour of the raw fibre; it had also great capacity for bleaching." In regard to its future in India, Dr. Watt states, "no fibre of modern times affords better hopes of success than Sida."

Remarks.—The fibre bundles are similar to jute in all structural points. The filament is 1·5 to 2 mm. long, hardly distinguishable from jute.

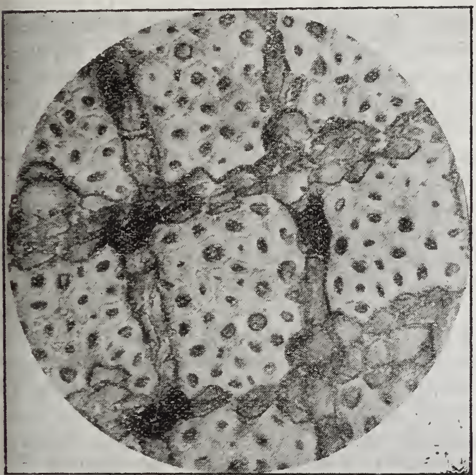
Jute.

Jute (*Corchorus capsularis*). — The jute trade of India is of the annual value of £10,000,000 sterling. There are about 2,000,000 acres under cultivation. The plants yielding jute are of two species. The one now under consideration is an annual, about 2 to 5 feet high. The base of the leaves is prolonged into two curious tail-like appendages. The fruit is a globose capsule, not beaked. The seed is sown broadcast in March to June and the crop is gathered to the end of September. It therefore occupies the ground only for about three to four months. When the stems are ripe they are cut down and steeped in water for several days, until the bark is rendered soft and loose. The fibre is taken off by hand, and after being thoroughly washed it is hung up in the sun to dry. The preparation is, therefore, very simple, and no machinery of any kind is necessary. The best qualities of jute are of a pale, clear colour, with a silky lustre, easily spun and comparatively strong. There are numerous commercial sorts varying in colour, degree of fineness, and in lustre. Those of bad colour are chiefly used for gunny bags. To lessen the harsh and brittle character of jute it is subjected to a crushing process with oil and water which softens the fibre and prepares it for the spinning processes. Dundee

has long held a supreme position as the seat of jute manufacture, but many factories have, of late years, been started in India. The class of goods manufactured is not, however, the same.

The chief defects of jute are—(1) The fibre will not bleach readily; and (2) fabrics manufactured from it are apt to rot, when exposed to damp. It is, however, extensively used in the manufacture of gunny bags, gunny cloths, rope, twine, carpets, rugs, and printed tapestry.

FIG. 6.



JUTE (*Corchorus capsularis*).

Section, highly magnified, through a portion of the bast region, showing the rectangular form of the fibre bundle, divided by plates of loose cellular tissue. × 300.

Remarks.—Jute fibre consists of the fibre bundles, cleaned by retting and washing. Each bundle consists of 6 to 20 cells. The latter are firmly coherent in the bundle. The cells are of the normal fusiform type, from 1·5 to 3 mm. long. In section they are thick-walled and polygonal.

Calcutta Jute (*Corchorus olitorius*).—The plant yielding the jute chiefly produced in the neighbourhood of Calcutta is very similar to the common jute; but the fruit is horn-like, instead of globular, and possessed of a distinct beak. It is cultivated in many parts of the world as a vegetable, under the name of the "Jew's mallow." As a fibre plant it is regarded as of less value than the previous species. The methods adopted for its cultivation and the extraction of the fibre are identical with those of common jute.

Chinese Jute is in some cases derived from the same plant as Indian jute (*Corchorus*); but some fibres exported from China as jute are yielded by very different plants. It appears that "jute" pays an export duty of 2 mace per picul, while "hemp" is charged 3⅓ mace per picul. There is, therefore, an incentive to pass all fibres as jute instead of under their proper names. American jute is sometimes an *Abutilon* fibre, and sometimes identical with Indian jute (see *Abutilon Avicennæ*). A West African jute from Lagos is described in the "Kew Bulletin," 1819, p. 15. This is known locally as Bolobolo fibre. It is yielded by *Honckenya ficifolia*. In 1889 the fibre was valued at £16 to £17 per ton.

HIBISCUS FIBRES.

Numerous species of *Hibiscus*, or mallows, are known to yield very serviceable fibres. The following are a few of the most notable:—

Deccan Hemp (*Hibiscus cannabinus*).—This is also known as Kanaff and Ambari hemp. The plant is a slender herb; the flowers are yellow, with a crimson centre. The fibre is said to be strong and durable, but so far is not known in commerce. Latterly it came into notice under the name of Kanaff, in the Caucasus ("Kew Bulletin," 1891, pp. 204-206).

Okra (*Hibiscus esculentus*).—An annual herb, yielding a fruit used as a table vegetable known as okra, okro, or gombo. The stem contains a useful fibre with great strength and lustre; it is adapted for making ropes, twine, and sacking.

Rozelle, or Red Sorelle (*Hibiscus sabdariffa*).—An annual shrub. The succulent calyx is edible, and is used for making cooling drinks. The fibre is strong and silky, and is known as Rozelle hemp.

Maholtine (*Abutilon periplocifolium*).—A shrubby plant with stems 8 to 10 feet long, common in tropical America, but also found in West Africa and the Nile Valley. This is recommended as yielding a jute fibre of considerable merit. Specimens sent to Kew from Trinidad, in 1889, were valued at £17 per ton. An account of the Maholtine as a new fibre plant is given by Mr. J. H. Hart, F.L.S., in the "Agricultural Record," (Trinidad), vol. i., p. 217.

Ban-ochra (*Urena lobata*).—A very variable plant, widely distributed in the tropics. In India, the easily extractable fibre is considered suitable for the manufacture of sacking and twine, and a fair substitute for flax. The "Toja" fibre of West Africa is yielded by this plant. Samples sent to Kew, in 1889, were valued at £17 to £18 per ton.

Remarks.—The fibre bundles are indistinguishable from characteristic *Hibiscus* fibre. The filaments or cells are short, scarcely more than 1·5 to 2 mm. long.

Indian Mallow Hemp (*Abutilon Avicennæ.*)—This is also known as China jute and American jute. The plant is a shrubby mallow, with yellow flowers. The fibre is said to be superior to Indian jute. An account of the plant, giving particulars respecting the cultivation and extraction of the fibre in China, is given in the "Kew Bulletin," 1891, pp. 255-256.

Of plants belonging to the Leguminous order we have so far only mentioned the Sunn-hemp (*Crotolaria juncea*). The following also produce useful fibre.

Dhunchi Hemp (*Sesbania aculeata*).—This is of interest from the fact that the plant will grow in swampy situations. The stems are produced to the height of several feet. Royle states: "The bark yields a very excellent fibre for common cord and twine purposes, much superior in strength and durability to jute." From the pith of the twigs very singular and ornamental mats are also made in Assam.

Ko Hemp (*Pueraria thunbergiana*).—A trailing vine, producing flowers like a Wistaria, long known in China and Japan, yields a very interesting fibre. This is obtained from the succulent green stems, and is used, but less than formerly, for summer clothing. It is said to be more durable than China grass cloth.

Malu Fibre (*Bauhinia Vahlii*).—The plant yielding Malu fibre is one of the most extensive climbers of the Indian and Ceylon forests. It is most abundant in warm, moist situations. The fibre is universally used by the natives of India. Dr. Watt states: "It is one of the few vegetable fibres that will stand to be dyed, bleached, and worked up along with wool."

Miscellaneous.

THE LACE INDUSTRY OF FLANDERS.

Flanders contests with Italy the honour of having invented lace, and it has been established, says Consul Morris, of Ghent, that lace-making existed there before 1600. Reasons for the early superiority of Flemish laces, and their subsequent renown, are not wanting. The quality of the flax produced in the two provinces is unsurpassed; then the damp climate is favourable to the proper texture of the lace; the patient industry of the peasant women, and the low wages of labour have also aided; and, perhaps more than any other cause, the prevalent convent life, where, even to this day, thousands of young and old women are employed in producing lace, which they are always ready to sell at nominal prices. For three centuries certain convents have preserved their renown for certain qualities and designs. To obtain the best, at the cost prices, the purchaser must go where the lace has been produced for several generations. The manufacture of almost all the variously-named laces has been introduced into Flanders, and has been brought to perfection there. In many towns of Belgium schools still exist where girls are taught, from the age of five years, how to make lace. When ten years old, they are said to be able to earn their own livelihood. Of all laces, that known as Valenciennes is perhaps the most generally produced in Flanders. It was introduced in the 17th century. Ypres commenced its fabrication in 1656. In the year 1850, there were 20,000 women employed in the vicinity of that city in its production. Ypres produces this lace in a most beautiful quality and workmanship. For a design two inches in width 200 or 300 bobbins are required, and, for the widest patterns, at least 800 different threads are used. At the present day the Belgian monopoly in this article amounts annually to several million francs. The principal centres of the manufacture of Valenciennes are Bruges, Courtrai, and Menin, in West Flanders, and Alost in East Flanders. The city of Grammont is famous for its production of black lace. *Guipures de Flandres* had a great success in the 17th century. It is especially suitable for furnishing purposes, and is extensively employed for the decoration of curtains, bedding, and table linen. Bruges is the chief centre of its manufacture. As regards *Application d'Angleterre*, Flanders received from England the original idea of this design, but by improvement and alteration it became entirely adopted in Belgium, although still known under its original name. Other varieties are known under the general title of *Denielles d'application*. Brussels, Ghent, and Alost remain without rivals in these laces. There are said to be about 60,000 persons employed in lace-making in Belgium; the majority of them live in the two provinces of Flanders and sell their work to the local merchants in business at Ghent, Bruges, Courtrai, Ypres, and other towns.

SPANISH WINES.

The culture of the vine in Spain extends over an area of 3,500,000 acres, and the average annual production of wine, including that of the Balearic Isles and the Canaries, is estimated at 770,000,000 gallons. The principal wine-growing districts are to be found

Valencia, Catalonia, Old Castille, Arragon, Riona Navarre, Leon, Andalusia, and Estramodura. ıd the largest production is furnished by the pronces of Alicante and Valencia-Catalonia, Andalusia ıd Old Castille coming next in the order of importıce. According to the Italian Consul at Barcelona, ho has lately been conducting an inquiry into the ondition of the wine industry in Spain, the prointes of Valladolid, Alava, Tarragona, Valencia, nd Barcelona principally produce red wines, in hich a large export trade is carried on with France nd South America. Andalusia produces the famous herry and Malaga, wines which are much appreiated abroad, these competing on foreign markets ery favourably with the Italian products of Marsala nd Syracuse. There are considerable varieties of ed wines, and those held in the highest repute are rom Valdepenas, Arganda, and Benicarlo. The vines of Valdepenas, a district bordering on Malaga, re much appreciated in Spain as table wines, and hey are sold at about 1s. 3d. to 1s. 8d. a bottle. The same may be said of the Arganda wine, which esembles the Valdepenas, although it has more ody and colour. The Benicarlo wine is of all the ed wines the darkest in colour and the strongest. Among white wines, sherry holds the first place. Its export dates back for centuries, and its reputation has always been the same. The amount shipped each year from Spain represents a value of more than £2,400,000. There are two kinds of sherries—the dry and the sweet, and the latter comprises three varieties, the *Pajarete*, *Pedro-Gimenez*, and *Muscatel*. The *Pajarete* and *Pedro-Gimenez* are very similar in quality, and they are both produced from the grape known as *Pedro-Gimenez*. The *Muscatel* is produced from the grape of the same name, which is a sweeter grape than the *Pedro-Gimenez*. This is the dearest wine in Spain, and is much appreciated, both at home and abroad. *Amontillado* is a kind of dry sherry, produced from a grape grown near Cordova; it has a good aroma, and the colour of clear amber. After sherry, Malaga wine enjoys a high reputation in Spain. There are two kinds of Malaga wine, the sweet and the dry. The export trade in this wine is of considerable importance, and is increasing yearly. *Manzanilla*, of all the Spanish wines, is, says the Italian Consul, "the most aromatic, and of the finest flavour." It is produced at San Lucar de Barrameda, near Cadiz, and it owes its name to the aroma of a kind of white camomile (*manzanilla*) that the grapes contain.

FOREIGN POPULATION OF AUSTRIA.

The Austrian Government has recently published the results of a special census of foreigners in Austria, similar to that which was undertaken in France a few years ago. It appears from this census that the number of foreigners in Austria, in 1869, amounted to 204,950; in 1880 this number had increased to 350,013; and in 1890 to 422,357. In France the number of foreigners amounted to 655,000 in 1866, and at the present time it is about 1,130,000. The general proportion of the sexes is about the same in France as in Austria, 108 men to 100 women, in the total of the foreign colony. It should, however, be observed that, in the case of the French, Swiss, and English who are living in Austria, the women exceed the men. Among the French this is particularly marked, for out of 2,726 French people living in Austria, 960 are men and 1,766 are women. This is to be accounted for by the fact that there are many French governesses exercising their profession in the large cities, and particularly in Vienna. The French colony in Austria represents, therefore, only a very small proportion of the foreign population. Hungarians (who are counted in this census as foreigners) count for more than half, and Germans for a quarter. The other nationalities having the most representatives in Austria are the following:—Italians, 46,312 persons; Russians, 18,149; natives of the Balkan States, 9,365; Swiss, 6,777; Roumanians, 2,672; Turks, 2,384; British, 2,261; and Armenians, 1,729. Among the provinces containing the largest number of foreigners are the following:—Bohemia, 39,029; Styria, 32,710; Galicia, 29,981; Trieste and its territories, 22,051; Silesia, 16,107; Moravia, 15,574; and Tyrrol, 14,403. Those provinces, on the other hand, which have the smallest number of foreigners are Carniola, Carinthia, Salzburg, Bukovina, and Dalmatia.

Obituary.

Louis Pasteur.—By the death of Pasteur, at Garches, near St. Cloud, on Saturday, 28th September, France has lost one of its greatest men—one whose services to mankind have long been acknowledged by the whole world. His researches have been so far-reaching, and have had so profound an influence on the progress of the world, more especially in connection with medicine, brewing, viticulture, sericulture, and stock rearing, that his name has been widely honoured as that of one of the greatest benefactors of the human race. Sir Joseph Lister, who represented England at the celebration of Pasteur's seventieth birthday at the Sorbonne, on the 27th December, 1892, said:—

"There is certainly not in the entire world a single person to whom medical science is more indebted than to you. Your researches on fermentation have thrown a flood of light which has illuminated the gloomy shadows of surgery and changed the treatment of wounds from a matter of doubtful and too often disastrous empiricism into a scientific art, certain and beneficent. Owing to you surgery has undergone a complete revolution. It has been

stripped of its terrors, and its efficiency has been almost unlimitedly enlarged. But medicine owes as much to your profound and philosophic studies as surgery. You have raised the veil which had for centuries covered infectious diseases. You have discovered and proved their microbic nature; and, thanks to your initiation, and in many cases to your own special labour, there are already a host of these destructive diseases of which we now completely know the causes. This knowledge has already perfected in a surprising way the diagnosis of certain plagues of the human race and has marked out the course which must be followed in their prophylactic and curative treatment. Medicine and surgery are eager on this great occasion to offer you the profound homage of their admiration and their gratitude."

Pasteur was born at Dóle on December 27th, 1822, and took his doctor's degree at Jena in 1847, and was appointed Professor of Physics in the Faculty of Strasburg in the following year. He returned to Paris in 1857 and undertook the scientific direction of the Ecole Normale. In 1856 the Royal Society awarded him the Rumford medal for his researches on the polarisation of light, and in 1869 elected him a foreign member of their body. In 1863 he was elected a member of the Institute of France, and in 1882 a member of the Académie Française. In 1874 the National Assembly voted him a life annuity of 12,000 francs for his investigations on fermentation, and in 1878 he was raised to the rank of Grand Officer of the Legion of Honour. Pasteur's industry was immense, and his writings were voluminous, the latest of his researches being those connected with the inoculation of diseases other than small-pox, and the cure of hydrophobia. The Institut Pasteur was founded at Paris in 1888, and in the following year, Dr. Ruffer read a paper before the Society of Arts on "Rabies and its Preventive Treatment," in which he described the work of the institute. The Trevelyan Prize of the Society of Arts (consisting of a gold medal) was awarded to Mons. Pasteur, in 1884, for an exhibit at the International Health Exhibition at South Kensington, in Group I., Class 7 (the Chemistry and Physiology of Food and Drink); and the Albert Medal was awarded to him, in 1882, for "his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silkworms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

Notes on Books.

Practical Proofs of Chemical Laws. By Vaughan Cornish, M.Sc. London: Longmans, 1895.

This little handbook details a course of experiments suitable for first year students, and intended to serve as verifications of the laws of combining proportions; thus, the law of conservation of mass is illustrated by the synthesis of silver sulphide. Full directions for the experiment are given, and the results are stated, which were obtained in part by two of the author's pupils. The first pupil obtained ·9531 parts of sulphide from ·9534 parts of silver and sulphur, an experimental error of 3 parts in 9534, or ·03 per cent. The second pupil's error was 1 per cent. The average of 13 experiments by pupils was 5 per cent., all on the — side. In the same way the laws of definite and of constant proportions, the law of equivalent proportions, the law of multiple proportion, and the volumetric law of combination of gases, are practically illustrated.

General Notes.

Royal Photographic Society. — The first ordinary meeting of the new session will be held on Tuesday, October 8th, at the Gallery, 5a, Pall Mall East, at 8 p.m., when a paper by W. K. Burton, C.E., "On the Formation of the Dots of the Half-tone Screen-image" will be read. The President will deliver his annual address, to be followed by the presentation of the medals.

Exhibition at Kiev, 1897.—The French Consul at Odessa announces in a recent report that an exhibition is to be opened at Kiev during the year 1897. The sections will comprise agriculture, horticulture, forestry, gardening, live-stock breeding, botanical science, industries in general, and the mining industry in particular. It will remain open from July 10 to October 10, 1897. It has not yet been decided whether it is to be of an international character.

Tower-bridge.—According to the report of Mr. D. J. Ross, Engineer to the City Commission of Sewers, considerable changes in the traffic of the London streets have been effected by the opening of the Tower-bridge. London-bridge has been relieved daily of about 5,200 vehicles, Eastcheap of 2,200, and Fenchurch-street of 3,000, while the traffic of the Minories has increased daily by 2,200 vehicles, Liverpool-street by 900, Houndsditch by 700, and Bishopsgate-street Within by 600 vehicles.

School of Wood-carving. — The School of Art Wood-Carving, Central Technical College, Exhibition-road, South Kensington, has been re-opened after the usual summer vacation. To bring the benefits of the school within the reach of artisans, a remission of half fees for the evening class is made to artisan students connected with the wood-carving trade. One or two of the Free Studentships in the evening classes maintained by means of funds granted to the school by the City and Guilds of London School are now vacant. Forms of application for the Free Studentships, and any further particulars relating to the school, may be obtained from the manager of the school.

Journal of the Society of Arts.

No. 2,238. Vol. XLIII.

FRIDAY, OCTOBER 11, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

COMMERCIAL FIBRES.

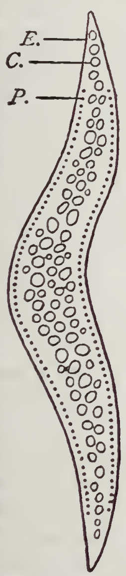
By D. Morris, C.M.G., M.A., D.Sc., F.L.S.,
Assistant-Director of the Royal Gardens, Kew.

Lecture II.—Delivered March 25, 1895.

Endogenous Fibres.

The fibres of Endogens or Monocotyledonous plants are found isolated in the stems and leaves. They do not form a continuous ring as in the bast fibres of Dicotyledonous plants. They occur in definite bundles, called fibro-vascular bundles, distributed in the cellular tissue, and usually enclosed in a bundle sheath. All the fibres proposed to be dealt with in this lecture are derived from the leaves of tropical endogenous plants. In fact, they may very appropriately be called leaf fibres, as opposed to the stem or bast fibres of exogenous plants treated in the last lecture. The mode of occurrence of the leaf fibres is very similar in all cases. A typical example is found in the valuable fibre obtained from the leaves of species of *Agave*. This fibre is known in commerce as Sisal hemp. The leaves in this case are sword-shaped, somewhat fleshy, firm in texture, and terminating in a sharp spine. They are arranged in a rosette, with about 30 or 40 leaves in each rosette. The most familiar example of this is the common American Aloe.

Fig. 7.

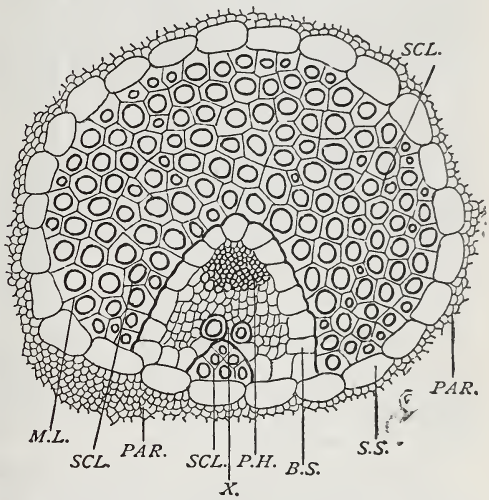


Sisal Hemp (*Agave rigida*, var. *sisalana*).

Transverse section through the middle of the leaf. The right hand side represents the upper surface; *E*, epidermis; *P*, peripheral row of bundles; *C*, central row of bundles.*

The above figure gives the appearance of an Agave leaf, cut transversely to its axis. The fibro-vascular bundles are of two kinds:—Firstly, there are the peripheral rows of small bundles, occurring immediately under the epidermis, on both surfaces of the leaf. These two rows extend from the centre outwards, but they terminate abruptly before they reach the margin. Secondly, there are the central bundles of fibre, one row of which reaches quite to the margin of the leaf. These central bundles vary considerably in size, those near the centre being generally largest. At the centre the rows are two to four deep. The space between the bundles is occupied by small-celled tissue, called the parenchyma. This is merely a packing material, and is useless for fibre purposes. To find the fibre material, and its structure relatively to other tissues, we must examine one of the fibro-vascular bundles from the centre of the leaf.

Fig. 8.



Sisal Hemp (*Agave rigida* var. *sisalana*).

Transverse section through a fibro-vascular bundle embedded in (*PAR*) the cellular parenchyma. *S.S.* starch layer, forming a ring round the sclerenchyma (*SCL.*), with the fibre cells closely packed together. *M.L*, middle lamella. *B.S.*, bundle sheath. *X.*, xylem, or wood cells. *P.H*, phloem, or bast cells. × 300.

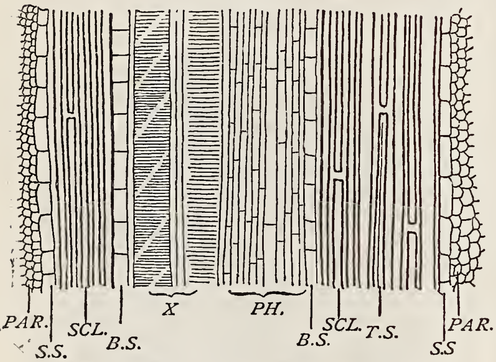
The whole bundle is surrounded by the small-celled parenchyma, only slighly shown in the above figure. Next comes the large, thin-walled cells of the starch layer, completely surrounding the bundle. Inside this is the large mass of tissue called the sclerenchyma,* somewhat crescent-shaped, and embracing within its two horns the vascular bundle. The crescent-shaped mass is made up of a number

* Figs. 7, 8, and 9 are adapted from a paper by Mr. C. H. Nicholls, B.A., in the *Journal of the Institute of Jamaica*, vol. i., p. 154.

* From the Greek *skleros*, stiff, hard.

of thick-walled cells with a central cavity. These cells form the fibre of commerce. The vascular bundle consists of two parts, the wood and the bast. In endogens the bast is useless for fibre purposes, hence it is incorrect to speak of the bast fibres of Monocotyledonous plants. To extract the fibre cells in this case it is necessary in the first instance to get rid of the small-celled parenchyma, and also of the vascular bundle. The fibre bundle would then consist (in section) of a crescent-shaped body made up of thick-walled cells only. These cells may number from 50 to 200 in each bundle. They are closely compacted by pressure, and their walls have grown so thick, that the internal cavity, in some cases, is almost blocked up. Each cell is really separated from its neighbour by a thin partition called the middle lamella.

Fig. 9.



Sisal Hemp (*Agave rigida*, var. *sisalana*).

Longitudinal section of a fibro-vascular bundle:—*PAR*, parenchyma; *S.S.*, starch-layer; *SCL.*, sclerenchyma; *B.S.*, bundle sheath; *X*, xylem; *PH.*, phloem; *T.S.*, transverse septum (termination of fibre cells). × 300.

The further structure of a fibro-vascular bundle is shown in a longitudinal section. On each side, as before, is the parenchyma, next the starch layer, and then the fibre cells or sclerenchyma. In the longitudinal section above *SCL.* is seen the somewhat abrupt termination of one or two of those fibre-cells (known as the transverse septum). Next to the sclerenchyma is the bundle sheath, *B.S.*, and then come the wood cells, *X*. These are long, wide, somewhat thick-walled, and characterised by peculiar ladder-like markings. Next to the wood cells comes the bast or phloem. The cells are mostly short, very delicate, and thin-walled. It is evident that they are useless for fibre purposes. The fibre cells, it is noticed, are very long; they have a narrow internal cavity, and lastly, they have thick cell-walls. All these points add to their value as a fibre material. They are the essential parts sought for in fibre plants, and, as will be shown later, they constitute in all cases the fibres of commerce.

Manila Hemp.

The plant yielding Manila Hemp (*Musa textilis*) is a wild plantain, native of the Philippine Islands, where several varieties are now cultivated for the sake of the fibre. The stem, made up of the leaf-sheaths, rises to the height of 12 to 20 feet, with leaves similar to the common plantain, but narrower. The fruit is hard and dry, not edible.

Cultivation.—The plant is propagated by means of suckers thrown out at the base of the parent stem. Plantations are established in fresh clearings on low hills and under the shade of trees, left standing at 60 feet apart. The cost of establishing plantations is about £5 to £8 per acre, not including the cost of the land. After this the yearly expense of weeding and maintaining the plantation in full bearing is at the rate of 30s. to 35s. per acre. The first crop is reaped at the end of eighteen months or two years after planting. The yield during the third and fourth years is at the rate of 400 lbs. to 700 lbs. of dry fibre per acre. The cleaning is done entirely by hand. No machine has yet been invented that will extract the fibre so efficiently and cheaply. A labourer, working under pressure, will clean about 20 lbs. of hemp per day. Usually two men work together, one cutting down the soft stems and splitting them, while the other cleans the fibre. In many cases the workers are paid one-half of the price of the fibre cleaned per day. At the current value of hemp in 1879, one labourer's earnings were estimated at 7½d. to 8d. per day. From these particulars it may be gathered that the Manila hemp industry in the Philippines is fostered by very exceptional circumstances. The plant is native of the country. It is cultivated on virgin soil, of which, in that part of the world, there is an unlimited extent; and, in addition, the labour supply is both cheap and abundant. It is important to bear these facts in mind in starting the cultivation of any fibre that is likely to come into competition with Manila hemp. Even in the Philippines there are districts in the western and northern parts, with a drier climate, where the plants will not grow. Hence it is useless to attempt to establish a Manila hemp industry in any country where the soil is not rich, and where there is not an

abundant rainfall well distributed throughout the year.

FIG. 10.

MANILA HEMP (*Musa textilis*).

Transverse section through a fibro-vascular bundle from the leaf sheath forming the so-called stem of the Manila hemp plant. The fibre cells are variable in diameter, with the cavity circular or oval. The divisions between the individual cells are more clearly shown in Fig. 8. × 300.

Fibre in Commerce.—Manila hemp is "the chiefest and best" of white cordage fibres. After it is extracted by hand it is thoroughly dried in the sun and packed by hydraulic pressure in bales ready for shipment. Hemp not properly dried, or exposed to rain, becomes discoloured and loses strength. It is characteristic of Manila hemp that it readily absorbs moisture and in an ordinary dry condition it contains 12 per cent. of "water of condition." The various qualities of Manila hemp in March, 1895, were selling per ton as follows:—Lupiz, £30 to £50; Quilot, £28 to £40; prime roping, £21 to £25; fair current, £17 to £18 10s.; seconds, £16; good brown, £14 10s.; common do., £13 10s. At this time Sisal hemp was selling per ton at £14; Mauritius hemp at £21 to £24; New Zealand Phormium at £12 to £14. The prices above quoted afford a very fair criterion of the relative value of these fibres. The position of Manila hemp practically determines the prices paid for all white rope fibres. About 50,000 tons of fibre are annually exported from the Philippine Islands, and the estimated value is not less than about £2,500,000 sterling. Although the bulk of the shipments of Manila hemp is received in this country a large part is re-shipped to the United States. For instance, in 1891 there were received 448,000 bales of Manila hemp. Of these 175,919 were re-shipped to America. The total receipts in the United States during 1891 (direct and indirect) were 316,677 bales. If we include Manila and Sisal hemp the consumption of these fibres in the United States is more than twice as much as in the United Kingdom.

Economic Uses.—Manila hemp is largely used as a material for white ropes for rigging and other purposes, It is also largely used for binders for reaping machines. Old Manila ropes make an excellent paper material. The manufactured articles made of Manila hemp in the Kew Museum consist of mats, cords, hats, plaited work, and lace handkerchiefs. One of the latest applications of this fibre is in the manufacture of lace and materials for ladies' hats and bonnets.

A successful attempt to establish a Manila hemp industry in British North Borneo has lately been reported. Owing to the heavy taxes in the Philippines it is claimed that North Borneo can export its fibre at a lower cost than the Philippines.

PLANTAIN AND BANANA FIBRES.

Besides Manila hemp, produced by *Musa textilis*, other species produce fibre useful for cordage purposes, for mats, and for making coarse paper. The plantain, in Jamaica (*Musa sapientum*, var. *paradisiaca*), produces a white, glossy fibre at the rate of 1·81 per cent. of the gross weight. The price of the best plantain and banana fibres is, however, seldom above £12 per ton, and they would only fetch this price when there is a high demand for white-rope fibres, and a short supply of Manila and Sisal hemps. In spite of this, it is worthy of consideration, whether the immense number of banana stems cut down every year in the West Indies (estimated at 50,000,000) could not be utilised for their fibre. It is evidently not sufficiently good to compete with first-class rope fibre, but it might possibly be used for making coarse paper, as a packing material, or even for the manufacture of *papier maché*. The Abyssinian banana, *Musa Ensete*, yields a somewhat weak and dull-looking fibre. *Musa Bajoo* is grown in Southern Japan for its fibre, which is woven into cloth of an exceedingly durable character. *Musa sumatrana*, forming an impenetrable jungle in the Malay Peninsula may eventually prove a useful fibre plant. A banana, native

of the Solomon Islands, yields fibre which is woven into ornamental garments, bags, and sleeping mats.

Pine-apple Fibre.

The common pine-apple (*Ananas sativa*) has a rosette of 30 to 50 narrow, strap-shaped leaves, from 3 to 5 feet long. These contain an abundance of fibre which, though somewhat difficult to extract, is possessed of great merit. It is finer and stronger than that yielded by almost any other plant except China grass. In the East Indies it is manufactured into a beautiful fabric known as "piña" cloth. In the Straits Settlements, Sierra Leone, and some other localities in the Old World, this tropical American plant has become thoroughly naturalised. The leaves in these semi-wild plants are more highly developed than in plants cultivated for the fruit, and hence are better suited for fibre purposes. In the Philippines it is also customary to pluck the fruit before it matures; this is said to cause a considerable extra development of the leaves.

Pine-apple plants are grown in every tropical country, and their cultural treatment is well known. They are easily propagated by means of offsets from the base. The leaves are fully developed in about 12 to 18 months, and each plant could yield at least 10 to 20 leaves every year. For piña cloth the fibre is extracted by scraping by hand, then washed and laid out to bleach in the sun. The steeping, washing, and drying are repeated until the fibres are considered to be properly bleached. The fibre bundles are very fine, transparent, strong, and supple. The ultimate cells are from 2 to 5 mm. long, fine, uniform in diameter throughout, solid and glossy.

A sample of pine-apple fibre of excellent and extraordinary length (6 feet), grown at Malacca, was brought to this country by Mr. Derry in 1893. It was stated, in the "Kew Bulletin," 1893, p. 368, that one manufacturer was hopeful of using 1,000 tons a year or more of this fibre at the price of £30 per ton, delivered in London. "Pine-apple hemp" is a regular article of export from Formosa to Swatow, where it is made into fine "grass cloth," esteemed for its coolness as a summer wear.

Caraguatá Fibre.

Caraguatá (*Bromelia argentina*). — The best fibre of Paraguay is "Caraguatá ibera." It is described as long and silky. There is frequent mention of it in works of travel, and fine specimens were shown in the Paraguay Court at the Exposition Universelle, held at Paris in 1889. Specimens of the plant, abundant in a wild state, were received at Kew in 1890, and it was found to be a new species of *Bromeliaceæ* allied to the pine-apple, which it resembles both in habit and character of the leaves. In a report furnished to the Foreign-office by Mr. Arthur Herbert (No. 1,006, 1892), it is stated "the *ibera* is a sort of caraguatá, and its fibre is of a finer quality than that of its congener, but neither of them has obtained any importance in commerce owing to the cost of cleaning and separating the fibre from the leaves. Several attempts have been made but so far without any great success. From the interest that has been awakened in this product in European markets it would seem to deserve a more serious study, and the opinion seems to prevail that with improved machinery and more skilful administration more profitable results might be obtained." Any machinery that could successfully extract pine-apple fibre could also clean the caraguatá fibre. It is anticipated by those acquainted with the local circumstances that caraguatá fibre will some day form an important article of export from Paraguay.

Other Bromelia Fibres.

According to the "Kew Bulletin," 1887, April, p. 8:—

"There are several samples of a wild pine-apple (*Bromelia sylvestris*, Willd.) from the West Indies and Central America at Kew, but there is no record of their commercial value. A sample supposed to be from this plant was lately sent from Trinidad, upon which the brokers reported as follows:—'Not yet in commercial use, but destined, we think, to a successful future; fine, soft, supple fibre, strong and good colour, ample length; say £30 per ton and upwards.'

"The fibre of the Jamaica Pinguin (*Bromelia Pinguin* L.) would appear not to be of high value. The plant covers hundreds of acres in the plains and lowlands of Jamaica, and an effort was made some time ago to prepare the fibre for commercial purposes. The report of brokers upon a sample of 90 lbs. was as follows:—'A long, towzelled, weak fibre, of bad colour, coarse, no strength, and only fit for breaking up. Similar to St. Helena hemp tow, but not so good. We should think £12 to £10 per ton the utmost value.' Several samples of this Pinguin fibre from Jamaica and elsewhere, cleaned both by hand and by machine, are to be seen in the Kew Museum, No. II."

Another bromeliad (*Karatas Plumieri*) with leaves 8 to 10 feet long, armed with distant,

incurved teeth, is common in tropical America. It is a well-known and valuable fibre plant. It is said to be used by Indians in making the finest hammocks in Central America, Guiana, and Brazil.

Bowstring Hemps.

The species of *Sansevieria* yielding Bowstring hemps have creeping rhizomes and a rosette of leaves of a fleshy character, sometimes flat, concave, round, or spear-shaped. The flowers are in spikes or clusters, white or green. The leaves are dark green, more or less succulent, and banded or mottled with white or black markings. They abound in a very valuable fibre, remarkable alike for fineness, elasticity, and strength. The Sansevierias are chiefly of African origin, but one at least may be Indian. Some of the species are already widely distributed in tropical countries. They are capable of being propagated very readily. Usually the rhizomes are divided and planted; plants may, however, be raised from seed, or, better still, from the leaves, which, if cut into pieces about two or three inches long, readily take root in moist situations. Plants may be put out at 3 or 4 feet apart. The first leaves for cutting may be produced in three to four years. In India, with *Sansevieria roxburghiana*, 1 lb. of fibre was extracted from 40 lbs. of small green leaves. It was calculated that "one acre would yield 1,613 lbs. of clean fibre at a gathering, two of which may be reckoned on yearly." So far Sansevieria fibre is not in commerce. It is, however, used largely in India—where it first received the name of bowstring hemp—in Ceylon, and on the West Coast of Africa for twine and cordage, and is regarded as most valuable. The fibre of *Sansevieria cylindrica*, known in Angola as "Ifé," is said to be the best fitted for deep sea sounding of any fibre known. The special merits of the fibre yielded by each species will be mentioned below.

Konje Hemp (*Sansevieria guineensis*).—One of the oldest and best known species. The mottled leaves are somewhat flat and leathery, about 3 to 4 feet long, 3 inches broad in the middle. On the Zambesi it yields "a valuable fibre similar to Manila hemp." It grows "in great abundance in many places, keeping to the shade of woods." In Mauritius, Jamaica, Cuba, and Trinidad it is semi-wild and yields excellent fibre. In Jamaica the return, under favourable conditions, is estimated at 1½ tons of dry fibre per acre, of the gross value of £45. Samples received in this country from Trinidad, in 1886, were valued at £20 per ton, but the colour and strength were not normal. Good machine-cleaned fibre from Cuba is said to have realised £50 per ton.

Sansevieria longiflora.—This plant is a native of equatorial Africa. The leaves are like those of *S. guineensis*, but usually larger or flatter, and not invariably blotched with green. The best distinction is the individual flower, which is 3¼ to 4 inches long, while in *S. guineensis* it is only 2 inches long. Fibre from *S. longiflora*, grown at Kew, was described in 1887 as "very bright, clean, and strong; in every way a most desirable commercial article. It would compete with the best Sisal hemp for rope-making purposes. Value £30 per ton."

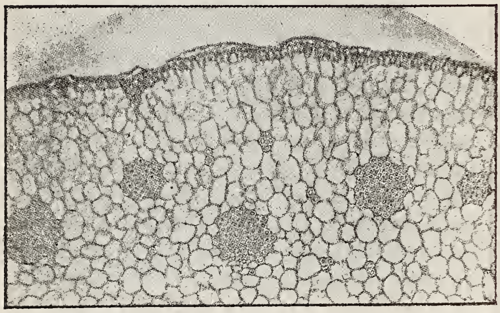
Pangane Hemp (*Sansevieria Kirkii*).—The leaf is very horny in texture, with a brown edge, much mottled on both sides. This species was discovered by Sir John Kirk, who states, "It grows abundantly near Pangane on the mainland opposite the island of Zanzibar . . . it is used by the natives and yields a long and useful fibre." The robust habit and large size of the leaf of this plant render it very valuable for fibre purposes. Under exceptional circumstances a single leaf will attain the height of 9 feet. Fibre from a plant grown at Kew was valued in 1887 at £27 per ton.

Neyanda (*Sansevieria zeylanica*).—This has long been cultivated in Ceylon. The leaves are semi-circular in transverse section, 1 to 2 feet long, dull green with a red margin, and copiously banded with white. The Singhalese use the fibre in numerous ways for string, ropes, mats, and a coarse kind of cloth. Generally the fibre is prepared by retting or by simple beating and washing. The small size of the leaves, and the difficulty of handling them in large quantities, would render this species of less value commercially than any of the preceding.

Ifé Hemp (*Sansevieria cylindrica*).—This is a most distinct and curious-looking plant. The leaves are quite cylindrical and solid, about 3 to 4 feet long, and about an inch in diameter at the base. When growing they look like a cluster of sharp-pointed stems. The species extends across South Africa from Zanzibar to Angola. The fibre, as already stated, is very valuable. Specimens prepared from plants grown at Kew were valued at £28 per ton. *S. sulcata* is very similar, but the leaves are more slender, with rather deeper vertical grooves. The fibre is slightly weaker, and valued at £26 per ton.

Moorva or Indian Bowstring Hemp (*Sansevieria roxburghiana*).—This plant was long confused with *S. zeylanica*, but Sir Joseph Hooker ("Flora of British India," vi., p. 271) has shown it to be quite distinct. The leaves reach 4 feet in height, narrow and semi-circular in transverse section, faintly clouded with black. The plant is cultivated for the sake of its fibre, and is the original bowstring hemp plant. The many uses to which the fibre is applied in India are fully described in Watt's "Dictionary of the Economic Products of India," vi., pt. 2, p. 460.

FIG. 11.



BOWSTRING HEMP (*Sansevieria sulcata*).

Transverse section through a portion of a leaf below the surface. Beginning from above are the cuticle, epidermis, and large-celled parenchyma. Embedded in the latter are the fibro-vascular bundles, varying in size. The cells are thick walled, with a small cavity.

As regards the foregoing species, it may be mentioned that the fibre of Sansevierias, in competition with Manila and Sisal hemps has possibly very little future before it. It is, however, so soft and silky, and possesses so much elasticity and strength, that it is well-fitted for numerous other uses. The fibre cells have a length of 1·5 to 3 mm. When more widely known and dealt with on an extensive scale, the Bowstring hemps are likely to prove most valuable. They flourish in rather damp situations, under the shade of trees, and extensive areas in West Africa and other countries could be devoted to the cultivation of these plants. When once established, they remain as a permanent crop, yielding regular cuttings of leaves two or three times a year.

Somali-land Fibre (*Sansevieria Ehrenbergii*).—This was first brought into notice in 1892, under the name of "aloe" fibre. The plant was determined at Kew as a species of *Sansevieria*, first collected by Dr. Schweinfurth between Athara and the Red Sea, and named by him *S. Ehrenbergii*, It is growing in large quantities in Somali-land, on the African coast opposite Aden. The leaves are solid, and almost circular, very stout and rigid, glaucous, and terminate in a strong, rather sharp point. Some are over 7 feet in height.

The fibre received in this country was described by Messrs Ide and Christie as "an excellent fibre of fair length, and with plenty of life . . . . with the exception of its colour, its preparation is perfect, and even as it is we value it to-day (27 June, 1892) at £25 per ton."

This plant differs from other species of *Sansevieria*, as it is evidently adapted to very arid conditions. It might, therefore, be found valuable for cultivation on land too dry for other produce. Lieut.-Colonel Stace mentions that there is any "amount of 'aloe' within reasonable distance [of the Somali coast], and it would be much improved by being properly cultivated." In preparing the fibre "the plant is not cut, but pulled out of the ground, and the sharp points cut off. It is then divided into two down the middle, and beaten with a stick until quite soft. The pieces are then drawn between two strips of wood fastened tightly together until all the pulp is squeezed out; no water is used. When quite dry, the fibre is ready for shipment." It is specially mentioned that the fibre must be extracted directly the plant is gathered, or it is spoiled.

SISAL HEMP.

Sisal hemp, Henequen, or Yucatan hemp, is produced by a species of *Agave*, native of Mexico, of which the common "American aloe" is the type. There are two, if not more, varieties cultivated for fibre. The chief one is the "Sacqui" (*Agave rigida*, var. *longifolia*). Plants were received at Kew in 1879, and again in 1890. The other is the "Yaxqui" (*Agave rigida*, var. *sisalana*). The former has leaves with side teeth, and a strong terminal spine; the latter has the terminal spine only; the edges of the leaves are smooth.

Cultivation.—These Agave plants are propagated either by suckers from the base of the stem, by seed, or by bulbils (called "pole" plants) produced on the flowering branches. The latter appear in the axils below the flower, and number many thousands. They remain in the parent plan until they are about four to six inches long, and sometimes much longer.

The land suited for the cultivation of Sisal hemp is entirely different from that required for Manila hemp. The best fibre districts in Yucatan possess an arid climate, with gravelly,

stony, or rocky soils; they are only a few feet above the level of the sea; the summer heat is intense. It is claimed that the fibre is stronger and more abundant in dry, hot soils than in rich, deep soils. The plantations are formed with young plants about 18 to 20 inches high. These are put out in rows, at distances varying from 6 to 12 feet apart, equal to about 600 to 1,000 to the acre. Broad lanes are left here and there for the purpose of making roads or tramways, all converging on the factory, where the leaves are cleaned. A plantation begins to yield in three to five years, depending on the size of the plants when first put in, and the nature of the soil and cultivation.

Harvesting.—When the leaves are fit to cut 10 to 20 are taken from each plant, beginning from below. The cutting may be repeated two or three times a year according to the vigour of the plants. As soon as a plant shows signs of "poling" it is regarded as useless for fibre purposes. The pole is cut out and the remaining leaves are harvested soon after. To provide for the continuance of the plantation "it is the custom to place at the foot of each plant (when about three-fourths of its life are spent) a small plant which replaces the old plant when the latter is removed." The period of the life of a plant may extend from five to ten years or more. Cutting the leaves too severely will accelerate the poling of the plant and thus destroy its usefulness.

Extracting the Fibre.—The leaf-cutters are paid at the rate of 25 cents per day for 200 leaves. The leaves are conveyed from the fields to the factory either on mule back or by means of light tramways. Each mule carries 200 leaves each trip; a task of 10,000 leaves requires ten trips, with five mules each. On the tramway a mule can draw a waggon with 3,000 leaves and make five trips a day. Most of the large fibre estates in Yucatan are provided with light portable railways on the French Decauville system. The more common machine used for extracting the fibre is the "raspador." It is a rude piece of machinery consisting simply of a wheel like a four-foot pulley with a six-inch face. Across the latter are fitted pieces of brass an inch square and six inches long, running across the face about a foot apart. This wheel runs in a heavy wooden frame and makes about 110 revolutions per minute. The leaf is put in at one end of the machine and held by a strong clamp while exposed to the beaters. The pulp is soon crushed out of it, leaving only the fibre. The leaf is then reversed and the other end cleaned in the same way. The average work of one machine, requiring 1½ horse-power, is 7,000 to 9,000 leaves per day with two men feeding. It is estimated that 1,000 ordinary leaves will yield 50 pounds of dry fibre. Exceptionally they will yield 100 pounds, but from strong plants from five to seven years old 75 pounds would be a good yield. After the fibre is cleaned it is spread out in the sun to dry. It is afterwards pressed into bales by lever or screw presses or by hydraulic pressure. The latter method is becoming general. The bales vary from 350 to 400 pounds, with a cubic measurement of 22 feet. It is calculated that the total cost of growing and cleaning the fibre and of delivering it at Progresso, the port of shipment, is about 3½ cents to 4 cents per pound Mexican money (about 1¼d. to 1½d. English money).

Position of the Industry.—The fibre plantations in Yucatan are estimated to cover about 224,000 acres. The total yield in 1892 was 350,000 bales of 375 lbs. each, giving a total weight of 131,250,000 lbs. For the whole country, this would be at the rate of 760 lbs. per acre. The actual return is probably a good deal more, as the total area under cultivation is not all yielding fibre. The estimated yield of the Yucatan plantations in 1895 was 400,000 bales. A State duty of 20 cents per 100 lbs. is levied on hemp exported from Progresso. A detailed account of the fibre industry in Yucatan is given in the "Kew Bulletin," 1892, pp. 272-277, and 1893, pp. 212-218. The latter was prepared by her Majesty's Vice-Consul at Progresso. A general account of Sisal hemp plants, and efforts to start industries in various countries is given in the "Kew Bulletin," 1892, pp. 21-40. Attached to this is a return of the average price per ton (spot value) obtained for Sisal hemp in this country for each month from January, 1879, to December, 1891. The following is a brief summary, based on this return, brought down to September, 1895:—

Year.	Highest.		Lowest.		Average for the Year.	
	£	s.	£	s.	£	s.
1879..........	32	10	21	0	24	0
1883..........	29	0	24	0	27	0
1889..........	56	10	45	0	50	0
1894..........	20	0	15	0	17	10
1895........ Jan. to Sept.	17	0	13	0	14	7

The fall in prices, so marked in the United Kingdom since 1889, was equally prevalent in the United States. This will appear from the following :—

Price per lb. in New York, Dec. 31.	1892.	1893.	1894.	1895 to Sept.
	Cents.	Cents.	Cents.	Cents.
	6 to $6\frac{1}{4}$	$3\frac{7}{8}$ to $3\frac{15}{16}$	$2\frac{5}{8}$ to $2\frac{3}{4}$	$2\frac{1}{2}$ to $4\frac{5}{8}$

Note added.—The monthly report on Sisal on the 15th September, 1895, showed a more favourable tendency. The spot value was £16 to £17 per ton.

Bahamas Pita.

The Sisal hemp or Pita industry of the Bahamas is of recent origin. It was regularly started about 1887. The plant is a native of Mexico, and identical with the "Yaxqui" of Yucatan—*Agave rigida*, var. *sisalana*. This is of a dark green colour, without teeth or prickles on the margin of the leaves, but with a black terminal spine. It produces suckers around the base, as well as bulbils and seeds on the flowering pole, as in the Yucatan plants. It is, therefore, well furnished with means for propagating itself over a wide expanse of country. Considerable interest has attached to the agency whereby the Bahamas became possessed of this valuable plant. The same plant is largely found in the south of Florida. This we know was brought there by Dr. Perrine from Yucatan, in 1836 and 1837. His intention was to cultivate it on a large scale for fibre purposes. About the same time he introduced 36 families from the Bahamas to settle on the land and supply the necessary labour. The Bahamas people were, however, frightened away by Indians, and could not be induced to return. Dr. Perrine himself soon after lost his life, and his plantations were abandoned.

The fibre plants were, however, destined to survive. They were carried about and planted as curiosities in gardens, and used as hedge-plants. Some found their way to Key West and to the neighbouring islands, and no doubt many were taken either by the settlers, or by some other means, to the Bahamas, as well as to Cuba and the Turks' islands. They are now present in all these islands. The introduction to the Bahamas from Florida is all the more probable because there has always been regular intercourse between them and the southern parts of that State. While, however, we give full credit to the probable introduction from Florida, it has been shown by Sir William Robinson, one of the most able of recent Governors in the West Indies, that some Pita plants were directly introduced to the islands from Yucatan by Mr. Charles R. Nesbitt, a former Colonial Secretary. This was in 1845. In 1851, just six years afterwards, when the plant had become established, "Mr. Nesbitt reduced a number of the leaves into fibre, and placed samples in the Nassau Museum." At the same time he sent specimens to England, and received very favourable replies as to their value, from London. It is evident that, for many years, Pita plants, all originally introduced by some means from Yucatan, have existed in the Bahamns. They have spread rapidly amongst the several islands and become, in some cases, troublesome to agriculture. It is evident also that, following Mr. Nesbitt's example, the plants were regarded as containing a valuable fibre, and likely to lay the foundation of an important industry. The difficulty was to obtain means for extracting the fibre in a satisfactory and remunerative manner.

In 1857, when Mr. C. J. Bayley, C.B., was Governor of the islands, there were sent for presentation to the Kew Museum, "Specimens of fibre, the produce of the leaf of the pine-apple and pita plants. The former is sent home," says the despatch, "in the hope of its applicability to the purpose of weaving; the latter from its abundance and uses as a material for the manufacture of paper." It is evident from this that the Pita plants were plentiful forty years ago. Many efforts were made by private enterprise, and also by the Government of the colony to draw attention to the existence of the plants, and offer suggestions for turning them to account.

In 1879, Sir William Robinson endeavoured to utilise the pithy flowering-stem, or "pole" of the Pita for the manufacture of razor strops. A specimen sent by him is now in the Kew Museum. A set of Pita fibres was afterwards sent to the Fisheries Exhibition of 1883, under the auspices of Sir Charles Lees.

In the Hand-book of the Colonial and Indian Exhibition, 1886, p. 181, Sir Augustus Adderley states, "the Pita plant, the fibre of which is so largely exported from Yucatan, is common everywhere in the Bahamas. There is an important future for the colony in this article." In the Bahamas Court at the same Exhibition there were shown by the Government of the colony "a rope made from the fibre of the Pita plant;" by the General Committee at Nassau,

"mats of fibre of the Pita plant," and "Pita fibre;" by Mr. W. W. Simonetti, "fibre of the Pita plant." This was during the Governorship of Mr. (now Sir Henry) Blake.

After the close of the Exhibition Sir Henry Blake, impressed with the valuable character of the Pita plant, brought the subject under the notice of the Secretary of State for the Colonies. After stating that "the question of the growth of the Pita plant for the production of fibre had assumed considerable importance," he asked "for any information available in this country as to the cultivation of Sisal in Yucatan and the methods adopted there for extracting the fibre." He added, "the plant grows here most freely and would soon materially increase our exportable productions if the fibre could be extracted with a small quantity of fresh water." These, as far as can be gathered, were the first practical efforts made to start a fibre industry. The Governor, in reply, was furnished with a copy of a report on the Sisal industry in Yucatan by Mr. Stoddart, recently published by the Government of Jamaica. It was pointed out that fresh water was not absolutely necessary to wash the fibre, or, at least, water was not generally used for that purpose in Yucatan.

In 1888, Sir Ambrose Shea, who had in the meantime succeeded Sir Henry Blake, took up the subject with singular energy and enthusiasm. Unconsciously, it may be, he took up the parable of his predecessors. It is, however, chiefly due to the personal effort and spirit of enterprise of this Governor that the industry has been so far established. He issued a circular dated the 22nd November, 1888, "to the Resident and Assistant-Resident Justices of the Bahamas on the position and prospects of a fibre industry which," he said, "is gradually being adopted by the people with a growing faith in its important bearing on their future welfare." From 1888 to the present time the progress of the industry has been comparatively rapid. The fibre was found to be of excellent quality, and during the period when white-rope fibres were in high demand it was valued at £56 per ton. Living plants of Pita were received for the first time at Kew, from Sir Ambrose Shea, in 1890. In 1891 it was reported that 4,100 acres were already planted. Several fibre companies were formed, the chief being the Bahama Fibre Company and the Munro Fibre Company. The head-quarters of the industry were at Abaco.

In 1892 the Governor reported that the "Fibre cultivation makes very satisfactory progress, and there are now about 8,000 acres planted out." A Commissioner was despatched in the same year to Yucatan "to study the whole subject of fibre cultivation and compare the circumstances of Yucatan and the Bahamas as regards, soil, climate, and the general healthiness of the plants." The Commissioner's report is published in the "Kew Bulletin," 1892, pp. 272-277.

From the Blue-book Report for 1893 we gather that the amount of land planted at the end of 1893 was 17,000 acres. "It may be expected that the annual increase would be about 6,000 acres. The value of the exported fibre was as follows:—In 1892, £592; 1893, £1,200."

The difficulty with regard to the fibre-extracting machine appeared to have been overcome. The Governor reported that "a machine manufactured by the Todd Company, of New York, has been at length found to work admirably, the fibre being cleaned perfectly at the smallest possible amount of waste." The small cultivators unable to get machines were said to be cleaning the fibre by soaking the split leaves in salt water for about a week, and then washing them by hand. About 50 lbs. to 60 lbs. of fibre could thus be cleaned in one day. The Governor continued:—"The generally accepted standard of 600 plants to the acre is being changed to 800, and in some cases to 1,000. If this increased number be not found to impede harvesting by the inconvenient crowding of the plants, the estimated yield of 1,200 lbs. per acre should of course be largely augmented."

It was unfortunate that the Bahamas industry was started when the price of fibre was exceptionally high. It led to exaggerated ideas being entertained as to the profits likely to be realised, and probably caused land to be planted that was unsuitable for the purpose. It also led to the enterprise being overloaded with capital, and to the cost per acre being increased beyond reasonable expectations of a suitable return. The same unfortunate mistake was made many years ago in starting the fibre industry in Mauritius. The result there was very tersely put by Mr. John Horne, F.L.S., in the following words:—"The fall in price in the European markets broke several local companies that were formed for working the 'aloe' estates. . . . There was too much money invested in them to pay."

It must always be borne in mind that all

white-rope fibres are liable to violent fluctuations in prices. These, in the case of Sisal, have ranged from £56 10s. per ton in 1889, to £13 in 1895. The fall in 1895 was unprecedented, and was evidently the result of a combination of circumstances, such as the high prices in 1889 stimulating over-production, and the great depression in the trade of the United States. Bahamas Pita will have to compete with the combined supplies of Manila, Sisal, and New Zealand Phormium. The production of these is already on a very large scale, and, given adequate prices, the supply could be increased within a very brief period. The average output of Manila is about 600,000 bales per annum, equivalent to about 75,000 tons. The approximate cost per ton of the fibre, delivered for shipment at Manila, is £18 (2d. per English pound); this allows the workman, who cleans it by hand, a daily wage of about 10½d. to 1s. The average output of Sisal from Yucatan is 360,000 bales per annum, equivalent to about 60,000 tons. This is double what it was a few years ago. The average cost per ton delivered at the port of Progresso is £14—about 1½d. per English lb.; the daily wage of the peons for plantation work, cutting the leaves, cleaning by machinery, and drying, is 25 cents (Mexican money). This would be equivalent, at the present rate of exchange, to about 8d. English money. In many cases task work is given, when the peons earn up to 1s. per day, or a little more. New Zealand Phormium, up to 1893, was produced in large quantities. The highest output was in 1890, when it reached 21,158 tons; in 1893 it had fallen to 12,587 tons. The actual cost of production delivered at the port of shipment is not given. It must, however, be about £12 to £15 per ton, as the prices lately ruling have almost stopped the supply. As possible rivals of Bahamas Pita, we have here a total production of 151,000 tons of white-rope fibres. The wages paid in the production of Manila and Sisal hemps are lower than those usually paid to negroes in the West Indies, and a good deal lower than would be paid to white labour in New Zealand. There is no prospect that, given good prices, the supply of Manila and Sisal in the future will either be exhausted or diminished. The supply of Phormium will be kept back only as long as the prices fall below the cost of production. Enhanced prices would have the immediate effect of stimulating production, and, as we saw in 1890, Phormium fibre could be placed in commerce to the amount of 21,158 tons annually.*

Having pointed out the difficulties of the situation at the Bahamas, it is only right to point out the advantages which they possess as a fibre-yielding country. It is in their favour that the plant under cultivation is acknowledged to yield the best Agave fibre known in commerce. Moreover, it has no side teeth as in the plants generally found in Yucatan, and the process of harvesting can be carried on more rapidly and at less cost. Further, in Yucatan there are many species cultivated—some of less value. In the Bahamas the plants are all of the best sort, and on that account the fibre should obtain uniformly higher prices than Sisal hemp. The possible value may be 10 to 20 per cent. higher than good ordinary Sisal. It has been proved that the soil for the most part, and also the climate are well adapted for producing strong, glossy fibre. The samples of Bahamas Pita in the Kew Museums are the finest of any there. No Agave fibre can, however, be intrinsically superior to Manila hemp; but with the exception of this one article, Bahamas Pita should take the lead, both as a white-rope fibre, and for binder's twine. It is possible that the disadvantage as regards the higher wages paid in the Bahamas may be overcome by the use of more efficient cleaning machines, causing less waste, and turning out a larger quantity of fibre per day, thus reducing the ultimate cost of production below that of Sisal. The anticipations under this head must, however, be qualified by the extent of unsuitable land already planted, and the heavy initial cost of establishing the plantations.

As regards freight charges to New York, they should be lower than for either Manila or Sisal. The position of the industry will, however, largely depend (1) on the effort made by all cultivators alike to produce a fibre of the highest quality to compete with Manila hemp or Sisal; and (2) by such rigorous reduction of the working expenses, that the fibre can be placed at the port of shipment below Sisal at any time, and, as a general standard, not exceeding the lowest prices of Sisal during the last three years. If these anticipations

* The disadvantages here enumerated as likely to effect Bahamas Pita would tell with still greater force against supplies of similar fibre from other countries where plants have been introduced at a considerable cost and cultivated under less favourable circumstances. This applies to India, Australia, and many British possessions.

were fully realised, the future of the industry would not fail to be satisfactory.

[Note added.—In Messrs. Ide and Christie's "Monthly Circular" for the 15th September, 1895, Bahamas Pita sold at £16 10s. per ton. This is a slight improvement on recent prices.]

Bombay Aloe Fibre.

Bombay Aloe (*Agave vivipara*).—The plant is a native of tropical America, but widely spread in the East Indies. It is extensively used as a hedge plant in India, in Bombay, and the North-West Provinces. The leaves are very long, narrow, and concave, with rather distant, brown teeth, and a terminal spine. Numerous bulbils are produced on the flower spike, hence the specific name. When white-rope fibres were in high demand, the fibre from *Agave vivipara* was prepared rudely by hand, and shipped from Bombay. It was, from the first, practically unsaleable. In 1890 the stock in this country had accumulated to over 1,000 tons. The prices quoted were from £5 to £12 per ton. As pointed out in the "Kew Bulletin," 1890, pp. 50-54, well cleaned fibre from this species was really worth at that time from £25 to £30 per ton. The difference in price was entirely due to the character of the cleaning.

A very similar fibre to Bombay aloe fibre was imported this year from Natal under the name of South African hemp. It was probably yielded by *Agave americana*. It was of bad colour, not well cleaned, and almost unsaleable. It is useless to ship fibre of this character from any British possession.

Manila Aloe Fibre.

Manila Aloe (*Agave vivipara*).—The plant known locally as "Maguey" is the same as that yielding the Bombay fibre mentioned above. It is also cleaned by hand. The value of the Manila fibre has always been slightly higher than the Bombay fibre, owing to its being presented in a cleaner condition. In March, 1893, Manila aloe fibre was quoted at 17s. per cwt., while Bombay aloe fibre was dull at 8s. to 13s. per cwt. It was only possible to produce the former when the price of white-rope fibres was exceptionally high. Of late years it has almost disappeared from commerce. In the Philippines the aloe fibre is used for making strings for violins. It is important to distinguish between this fibre and Manila hemp. The latter is yielded by *Musa textilis*.

Mexican Fibre or Istle.

Istle (*Agave heteracantha*).—This fibre is somewhat stiff and hard, and is described in commerce as "a unique substitute for animal bristles." It is used in the manufacture of cheap nail and scrubbing-brushes. The plants yielding it belong to a well-defined group of Agaves, of which *A. heteracantha* is the type, with stiff, somewhat narrow leaves, having a distinct horny margin, with or without teeth. They are natives of Mexico. The fibre in commerce is known under the name of the districts from which it is exported. Jaumave produces a long, clean fibre regarded as the best; Tula a shorter and coarser fibre, while Matamoras produces a short soft fibre, somewhat woolly in character, probably produced by species of *Yucca*.

The head-quarters of the Istle industry is at San Luis Potosi. The fibre is exported from Tampico. The whole supply of fibre is obtained from wild plants which are abundantly distributed over the plains and rugged slopes of several States in Mexico. The peons collect the fibre when not otherwise engaged on the work of the haciendas. The central mass of leaves (the heart leaves) of the plant are torn out, and when a sufficient quantity are gathered together the work of extracting the fibre begins. This is accomplished entirely by hand. The chief instrument used is a blunt knife called a *tallador*. Between this and a hard wooden block each leaf is passed, "once for one side, once for the other, and a third time to give it a finishing scrape." When the pile of fibre has reached a certain bulk it is spread out in the sun to dry. It is afterwards packed in 200 pound bales and forwarded by mule trains, often over a distance of 170 miles, to the nearest port. A very interesting account of the Istle industry is given by Mr. W. S. Booth in the "Kew Bulletin," 1890, pp. 220-224. Mr. Booth states, "the Agave and Yucca fibre industry is at present in its infancy. If intelligently followed it might become a very prosperous enterprise . . . where cheap labour and poor soil prevail. It might become still more prosperous by the use of economical machinery and intelligently managed plantations."

Other Agave Fibres.—The chief Agave fibres are Sisal Hemp, Bahamas Pita, Bombay and Manila Aloe fibre, and Istle. These have been already dealt with. In addition, some fibre is extracted in India, in the Mediterranean region, in South Africa, and more largely in Mexico, from the common American aloe (*Agave americana*). The fibre of this plant is very readily recognised; it has little strength, is poor in colour, and "gives" under

moderate strain. It has a "tousled" appearance, and on that account is sometimes dyed black, and used as a substitute for horse-hair. Almost of an identical character is the fibre extracted from the Keratto of Jamaica and the West Indies (*Agave Morrisii*), which is described as "towy, not an even fibre, of very little strength, and undesirable." There are many other species of Agave, such as *A. sobolifera*, *A. Keratto* (distinct from the Jamaica Keratto) and *A. lurida*, from which fibre is occasionally extracted, but generally this is done in ignorance of the true fibre-yielding species. For long, white-rope fibre, the best Agave plant is undoubtedly that exclusively cultivated at the Bahamas (*Agave rigida*, var. *sisalana*).

Mauritius Hemp.

The Green or Fœtid Aloe yielding Mauritius hemp (*Furcræa gigantea*) was introduced as a garden plant from South America, about 1790. It is known amongst the French as *Aloës vert*. In 1837 it had established itself spontaneously in many localities in the island. About 1872, the quantity of plants growing on abandoned sugar estates suggested their utilisation for fibre purposes. The first exports were 214 tons, of the value of £4,934. Since that time, with some fluctuations, due to the ebb and flow of demand, the Mauritius hemp industry has steadily advanced. The value of the exports is now about £50,000 annually. The plant has much the habit of an "Aloe," but the leaves are bright green in colour, and with no teeth or terminal spine. The leaves are often 4 to 7 feet long, and 5 to 8 inches broad in the middle. The flowers are greenish white, on a branched peduncle or "pole" 10 to 20 feet high. Bulbils are produced as in some species of *Agave*. The plant is chiefly propagated by means of these. Regular plantations are established on the same plan as those described under Sisal hemp. Plants that have "poled" are replaced by strong young plants from nurseries. The life of a plant is about seven to ten years. They are, therefore, cut for about four or five years before they pole. Overcutting the leaves tends to cause the plant to flower and die prematurely.

Fibre Machines.—The hemp industry in Mauritius was greatly advanced by the invention of local machines, called *grattes*. They cost about £20 each, and are worked by steam or water power. The grattes are on the same principle as the *raspador* of Yucatan, and consist of a drum, with bolted blades, which revolves at a great speed in front of a feed table, on which the leaves are placed. One gratte is served by two men, who work alternately; one of them must be left-handed. The out-turn of wet fibre for each machine is, on an average, about 94 lbs. per hour; the out-turn of dry fibre per day of eight hours for each machine is 214 lbs. The average cost of producing a ton of fibre ready for shipment in 1890 is 225 rupees. A full account of the Mauritius fibre machine is given in the "Kew Bulletin," pp. 98-104.

Mauritius hemp is not largely used for cordage purposes. It has special applications on account of its fineness and lustre, and is much used for ornamental purposes. The prices have been well maintained, in spite of the depressed condition of most fibrous substances during the last two years. In March, 1895, the quotations were:—"Good white, 21s. to 24s. per cwt.; fair, 17s. to 18s.; common, 14s." The imports in 1893 were 1,373 tons; in 1894, 684 tons.

Furcræa gigantea has been largely planted at the island of Anguilla in the Leeward Islands, under the direction of Sir William Haynes Smith, K.C.M.G. The plantation is about 350 acres in extent, and the first crop of leaves will be shortly harvested. Should the price of Mauritius hemp be maintained, the Anguilla plantation is likely to be very successful.

Silk Grass.

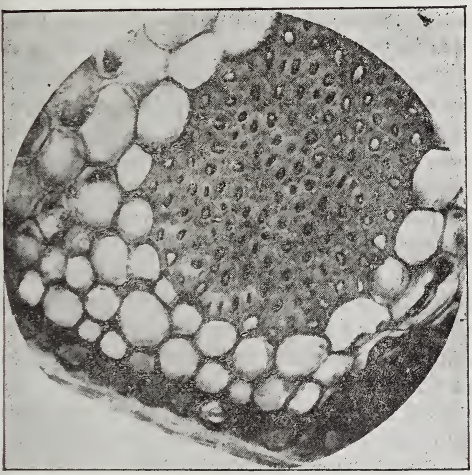
Although this term is sometimes applied to some species of *Bromelia*, it is more generally applied to *Furcræa cubensis*, one of the "green aloes," very similar in appearance to the plant yielding Mauritius hemp. It is a native of tropical America, and is cultivated in Jamaica and Tobago as a fibre plant. The leaves are 5 to 6 feet long, usually armed with strong prickles, but sometimes unarmed (as in the variety *inermis*), or with few prickles. The yield of fibre is at the rate of 2·5 to 3·15 per cent. Samples of silk grass fibre from Jamaica were valued, in 1884, at £27 per ton, and reported to be "superior to Sisal."

Another species, *Furcræa selloa*, with leaves 3 to 5 feet long, armed with brown horny teeth, is plentiful in Ceylon, but apparently scarce elsewhere. The fibre yielded by it is very similar to that of *F. cubensis*. Unlike the latter, however, it has no unarmed variety, and is therefore not likely to be widely cultivated for fibre purposes.

New Zealand Phormium Fibre.

The plant yielding this interesting fibre (*Phormium tenax*) is very variable. It belongs to the liliaceous order, and has very long, sword-like leaves, growing in opposite rows, and clasping each other at the base. There are two well-marked varieties. One has leaves 5 to 10 feet long, bright green above, glaucous beneath, with the flowers red; the other has shorter leaves, with the flowers yellow. The flowering stem is large, and alternately branched. It rises out of the centre of the leaves, reaching a height of 12 to 16 feet. The fruit is a three-valved capsule, containing two rows of small, flattened black seeds.

Fig. 12.



New Zealand Phormium (*Phormium tenax*).

Transverse section through a fibro-vascular bundle immediately under the surface of the leaf. Beginning at the lower left-hand corner, the tissues are as follows:—Cuticle, epidermis, large celled parenchyma (shown white in section), then the dark mass of the sclerenchyma, containing thick-walled fibre cells with a small cavity. × 300.

The Maoris are said to recognise about 55 sorts of the Phormium plant to which distinct names are given. The accepted number amongst Europeans is much less. Each shoot has five leaves, and about ten shoots go to a clump; there are therefore about 50 leaves in a clump. Exceptionally the leaves may be 10 feet high, but usually they are from 5 feet to 7 feet high. So far the Phormium plant is not regularly cultivated. The fibre is prepared wholly from wild or semi-wild plants. It is recommended to start plantations under favourable conditions, and make Phormium one of the established crops of the country. By such means it is anticipated that the leaves will be more uniform in character, and capable of yielding a better class of fibre.

Phormium has been the subject of extensive investigation in New Zealand for many years. Numerous experiments have been undertaken with the view of improving the methods of preparation, and extending the application of the fibre. The results have not been successful. The subject is still occupying the serious attention of the New Zealand Government. In 1893 the following premiums were offered:—(1) £1,750 for improvements in machinery which will materially reduce the cost of production of commercial fibre; (2) £250 for a process for utilising the waste products of the industry. The results of the trials in connection with these premiums have not yet been published. It is probable that experiments carried on in this country with fresh leaves would be more successful. It is to be expected that the conditions in New Zealand, in a comparatively new community, devoted chiefly to agricultural pursuits, are not so favourable for inventions as in the large manufacturing centres of England. A suggestion on this point is offered later.

It may be mentioned that the fibre of *Phormium* is neither a flax nor a hemp in the usual acceptation. It would be more correct to call it simply "Phormium fibre." It is one of the oldest exports of New Zealand. Between 1828 and 1832, although New Zealand was then visited only by whalers and a few traders, no less than £50,000 worth was shipped to Sydney alone. At that time the Maori hand-dressed fibre fetched a high price in the English market, under the name of "New Zealand flax." The Maoris were careful in the selection of the leaves, taking only those in which the fibre was properly ripened, instead of cutting over the whole plant indiscriminately and at all seasons. Machine-dressed fibre did not come into commerce until 1861, and then only to supply the deficiency in Manila for rope-making. It is estimated that an acre will yield about ten tons of sun-dried leaves, and that the usual yield of fibre is at the rate of 12 cwt. per acre. Phormium is pre-eminent for its high yield of fibre; this is at the rate of 15 to 20 per cent. of green leaves. The old Maori fibre was so well prepared that it was capable of being made into damask and towelling equal to fairly good linen. Specimens of these are in the Kew Museum. The machine-dressed fibre is defective in many respects, and suit-

able only for the manufacture of twine for reaping and binding machines. It is felt that the full value of the fibre can only be obtained by the use of a combined scraping and chemical process applied to carefully selected and properly matured leaves. This is well brought out in the following extract from the "New Zealand Official Year Book" for 1894:—

"The greatest improvement of the present system will be effected by the cultivation and careful selection of the leaves, and by the substitution of a chemical retting process for the prolonged washing and sun-bleaching which at present obtain. . . . The sodic-sulphate process suggested by Mr. Cross appears to be the most promising. The advantage of this process over any other is the very high yield of fibre it achieves, which exceeds one-fourth of the weight of the green leaf, no other process having yielded more than one-sixth. The quality of the fibre produced resembles the native-made fibre in lustre and strength. For the future, if the phormium plant is to become a source of fibre supply for the world's market, its cultivation must be established in favourable situations. The natural supply is now difficult to collect, and still more difficult to renew and perpetuate."

The shipments of Phormium are variable. Owing to the improved demand for fibres generally, the number of Phormium mills in New Zealand increased from 30 in 1886, to 177 in 1891. The approximate value of the industry during the same period increased from £43,094 to £234,266.

The exports of Phormium for 1881, and for the years 1888-93, showing the quantities and values, were as follows :—

Year.	Tons.	£
1881........	1,308	26,285
1888........	4,042	75,269
1889........	17,084	361,182
1890........	21,158	381,789
1891........	15,809	281,514
1892........	12,793	214,542
1893........	12,587	219,375

The figures since 1893 have shown a remarkable falling off in exports both to this country and America. The latter imported only 7,000 bales in 1894, as against 70,945 in 1893.

A careful investigation of Phormium fibre was undertaken by Mr. Cross in 1886. The results are published in the Reports of the Royal Commission of the Colonial and Indian Exhibition, 1887, pp. 373-376. As compared with Irish flax Phormium fibre contains a lower per-centage of cellulose, the actual figures being, Irish flax 80·2 per cent., Phormium 67·5 per cent. This cellulose in Phormium is also shown to possess a lesser stability than in flax. It is pointed out there is a very close structural resemblance between Phormium fibre and Manila fibre, so that in case Phormium may not be so useful as flax for the higher textiles it may be brought into more active competition than at present with Manila hemp as a white-rope fibre. The structural resemblance between Phormium and Manila hemp above noticed is corroborated by what takes place in commerce. "Phormium," writes one authority, "mixes well with Manila. When the demand in the States for binder twine runs on Manila then New Zealand Phormium is in such demand for mixing that it may go above Sisal in price."

The outlook in this direction is, however, not very promising. The supply of Manila, as well as Sisal hemp, could be considerably increased if prices went up, as there are large tracts of land still available for cultivation, and the labour supply is both cheap and abundant. Further, the question of freight has to be considered. Freight on New Zealand Phormium to the United States in 1892 was £4 10s. per ton, while on Sisal it was only £1. Again, by sailing vessel to the United States the freight on Manila was only £1 12s. 3d. per ton. By way of England it is more. The best opening for Phormium is evidently in the direction of supplying a good fibre for textile purposes, and here the field, at present at least, is not so fully occupied.

The prospects of the Phormium industry are very fully discussed in a paper presented to the Houses of General Assembly in New Zealand (H. 22, 1892), containing correspondence with the Agent-General in London. The latter states :—

"There are a number of skilled persons who, if they had sufficient inducement and full and proper opportunity [in this country] for ascertaining the nature of *Phormium tenax*, would direct their attention to the discovery of a means whereby the plant could be effectually and economically cleaned, so as to enable it to compete with Manila and Sisal."

He then offers the following suggestion :—

"It appears to me that what is wanted is the cultivation of the plant itself in this country to such an extent as would provide sufficient material for the purpose of supplying those whose skill and attention would be directed, on sufficient inducement being

offered, to the discovery of proper machinery for preparing the fibre for the market."

It may be added that the plant grows very freely in the South of England, the South of Ireland, and many localities with a warm climate south of the isothermal line of 51° Fahr. A plot of about five acres in extent would be amply sufficient to supply leaves for experimental purposes. The importance of the interests concerned would fully justify the New Zealand Government to act upon the suggestion here given.

Palm-leaf Fibres.

Several species of palms with feather-winged or pinnate leaves, are utilised for the fine fibre contained in the leaflets. This fibre is fine and hair-like, very soft, and, when unbleached, closely resembles flax. It is composed of the fine fibro-vascular bundles running through the substance of the leaflet. It is deftly extracted by hand in the young state before it is hardened by exposure to the sun. The process is slow and tedious, but the value of the fibre is undoubted. It is remarkable for great strength and durability.

Oil-palm Fibre (*Elæis guineensis*).—The oil-palm is the most valuable plant in West Africa. It is distributed in a wild state over the greater part of tropical Africa. The yield in palm oil and palm kernels is of the annual value of about £2,000,000 sterling. The fibre from the leaflets of the oil-palm has long been known in West Africa. Only small samples have occasionally reached this country. A very clear and graphic account of the method of extracting the fibre is given in the "Kew Bulletin," 1892, pp. 62-67 (with wood-cuts). The young leaflet is, first of all, deprived of the mid-rib for a short distance below the apex, and it is then split horizontally so as to expose the fibro-vascular bundles. These are taken up one by one, and usually twisted at once into a thin cord. If not so twisted, they are kept in small tufts, and eventually made up into a bundle. The threads are "as fine and tenacious as human hair." It is a hard day's work to prepare six ounces of this fibre from 36 lbs. of the raw material. It is estimated that the actual cost of this hand-made fibre cannot be less than about £75 per ton. It is almost exclusively used for making fishing lines and fine cord. A sample submitted to Messrs. Ide and Christie, in June, 1891, was described as of "great strength and fineness, and, if really spinnable, worth £50 to £60 per ton." This must be regarded as one of the most valuable and lasting of tropical fibres.

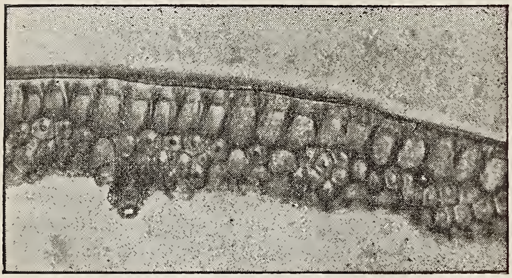
Gri-gri Fibre (*Astrocaryum* spp).—In the West Indies, at St. Vincent, and on the Atlantic slopes of Central America the Caribs extract a fibre from the young leaflets of the Gri-gri and other palms identical in character with that of the oil-palm. Demonstrations in extracting fibre were given by the Caribs sent from St. Vincent to the Jamaica Exhibition, 1891. It is evident that the process is widely known amongst native races. Everywhere the fibre is regarded as most costly and durable. A fine fibre is extracted also from the leaflets of *Astrocaryum Tucuma* in tropical South America. This is knitted by hand into a compact web of so fine a texture as to occupy two persons three or four months in its completion. The handsome hammocks afterwards made from the web sell for £3 each, or even double that amount.

Raffia.

Raffia is prepared by peeling off by hand the cuticle, or outside surface, of the leaflets of a Madagascar palm (*Raphia Ruffia*). This palm is widely spread in the island, chiefly in valleys, up to 4,000 feet. The pinnate leaves are 20 to 30 feet long; the narrow leaflets from 2½ to 5 feet long. The leaves are taken before they are fully expanded. The cuticle is peeled off on both sides. It appears as flat, straw-coloured strips, about half to three-quarter inch wide, and from 3 to 4 feet long. It is capable of being divided into fine threads. In Madagascar it is used for delicately-plaited goods, hats, mats for covering floors, and wrapping up goods. The loose strips are extensively used in this country in place of Russian bast or tie-bands by gardeners and nurserymen. More recently it has been woven into superior matting, tastefully coloured, and used instead of tapestry for covering walls in London houses. Raffia usually reaches this country loosely plaited in hanks, weighing from 1½ to 3 lbs. each. These are made up into bales weighing 1½ to 5½ cwt. The preparation of Raffia is one of the most extensive industries in Madagascar. The men cut the palm leaves in the forests, and bring them home, the women do the rest. The fibre is cured the same day it is stripped. The price, in Tamatave, during 1894, was from 5 to 9 cents for the best Raffia, and about 2 cents less for red or discoloured Raffia. "Practically everyone doing business in Madagascar

buys Raffia either for speculation, in barter for goods, on commission, or as agents."

FIG. 13.



RAFFIA (*Raphia Ruffia*).

Transverse section through the peripheral tissues of the leaf forming the commercial strips of Raffia. Beginning from above, the tissues are as follows: cuticle and epidermis; then the vertical cells of the palisade parenchyma; below these are the fibro-vascular bundles (four in number) the individual cells having strongly thickened walls. The strength of the strips is entirely due to the presence of these bundles.

Owing to the falling away of supplies from Madagascar, it has been sought to obtain Raffia from the Wine palm of the West Coast of Africa (*Raphia vinifera*). This already yields African bass, to be described later. Samples of West African Raffia were shown at the Colonial and Indian Exhibition, 1886. Small shipments have been made this year. The strips from West Africa are usually too short; they are curled together so as to resemble fine twine, and the colour is dull and too dark. If these defects could be remedied, there is no doubt West African Raffia would be in good demand. There is, possibly, a further source of Raffia from West Africa in the Black Run palm (which is known in India and Ceylon as the Palmyra palm). Excellent epidermal strips from this palm, nearly 7 feet long, are in the Kew Museum. These are longer than any received from Madagascar.

COROJO FIBRE.

A fine sample of Corojo fibre from Cuba was contributed by Messrs. Ide and Christie to Kew in 1890. At the time it was impossible to trace its origin. The strands of fibre presented a ribbon-like appearance somewhat resembling Raffia, but firmer and not so papery. They were extremely strong and capable of being divided into very fine tough filaments. On being handled it was noticed that the ribbons were armed with small spines as sharp as needles. These were not readily seen at first as they lie close to the fibre, but their presence was soon felt in passing the fibre through the hand. A careful examination showed that the fibre was formed of the epidermal layer of a palm leaf and probably derived from a species of *Bactris* or *Acrocomia* armed with prickles. In March of this year a further inquiry elicited the fact that the fibre was obtained from the unopened leaflets of the Gru-gru palm of the West Indies (*Acrocomia lasiospatha*). It is a remarkable fibre, and in point of tensile strength it surpasses even the oil-palm fibre already described. Its Cuban name is *Pita de Corojo*.

Miscellaneous.

THE MINING SCHOOLS OF GERMANY.

Among the many mining schools of Europe few if any are superior to those of Clausthal in the Hartz Mountains, and Freiburg, in the mineral mountains of Saxony. Throughout Germany the question of education, especially practical technical and industrial education, takes precedence of all others. In a recent report on the technical and trade schools of Germany the United States Consul at Chemnitz selects the Clausthal establishment as an illustration of what is best in the mining schools of that country. It is surrounded by mineral mountains, into which shafts have been sunk, and at whose bases are situated, in active operation, a great many smelting furnaces, machine shops, and factories. The value of these to the student is incalculable, and much of the success of the school is undoubtedly due to its favourable situation. Its origin, which dates back to the end of the 16th century, was due to a desire to furnish regular and exact instruction in the mathematics and mechanics necessary to the successful mining of the many metals and minerals known to be in the surrounding hills. Besides its service to the State on whose soil it is situated, it has received from and sent back to every State in the empire, and almost every foreign country, trained students of almost every trade or profession calling for skill in chemistry, mineralogy, mechanics, mathematics, &c. For four centuries the Hartz Mountains have been worked, and at the present day in spite of tremendous difficulties, by means of scientific methods, these mines are made profitable. The State works the mines and supports the school. Within a circle of three miles are the most important lead, silver, and copper mines, and the smelting works of the Upper Hartz. Some of the mines are worked to a depth of 3,000 feet, with veins 150 feet wide. One great advantage the students have is in seeing all kinds of ores smelted. Ores from

all countries come from Clausthal to enter the crucibles and come out refined. The school aims at giving such a scientific technical training as will fit the students to take charge of mines and smelting works of all kinds and sizes. There are practically two courses—preparatory and advanced. The preparatory course is to give those who wish to take the advanced or lecture course such a training as will enable them to get all the good out of the advanced course when they arrive at it. To this end the preparatory course carries them through the various works, plants, and machinery, until the student is familiar with technical terms, the *modus operandi*, &c. The course begins each year in the week following Easter Sunday, and continues twenty-four weeks. Eight weeks are devoted to mining, eight to the concentration of ores, and eight to smelting. In the advanced course, the lectures begin in October and close in July. There are very valuable geological collections connected with the school, and for the use of the students. The library has a collection of 14,500 volumes, covering almost every scientific subject, but more especially mines and metals. Besides this, the library of the Royal Mining Department (13,500 volumes) is at the disposal of the students; also a collection of over 500 models showing descriptions and structure of veins, rocks, &c.; appliances of various kinds, ancient and improved, for mines and metallurgical operations; machinery for dressing ores; for showing construction of supports, buildings, &c., supplemented by numerous charts and drawings used in illustrating lectures. There is a chemical library, with working room for fifty students at a time, with all the utensils, &c., necessary for practical work, such as preparations and apparatus to illustrate lectures on chemistry, and preparations for chemical technology; an assay laboratory, with everything needed for wet or dry assays; 500 excellent cabinet specimens to illustrate geologic conditions; a general collection of useful minerals, consisting of small specimens from all countries and classified; a collection of metallurgical products, ores, furnaces, fuels, &c.; a collection of instruments such as are used in surveying mines, and many other useful aids to a thorough knowledge of all appertaining to mining and metallurgy.

To be admitted to this school, students must be at least 17 years old, and must give proofs of a sufficient preliminary education and good moral conduct. Germans must show a certificate that they have gone through a German school of nine classes; foreigners must submit proof of equal qualification. There are special students, who are allowed to enter if it is considered that they have had an education sufficient to enable them to understand the lectures. Special students, after one year's faithful work, are granted the privilege of becoming regular students, by passing a good examination in elementary mathematics. For one hour a week, instruction in assaying, blowpipe, and volumetric analysis, a fee is charged of 4·50 marks (mark = one shilling); one hour in any other branch, 3 marks; daily work in assaying, or in quantitative and qualitative analysis, 60 marks for the winter term, and 45 marks for the summer term, and for one month, 18 marks; for assaying, one day per week, 24 marks for the winter term, and 18 marks for the summer term. These very moderate fees will show how easy it is for the Germans to get a good technical education. Students may be examined in any subject taught in the school, and in everything in mining and metallurgy. If successful, they get diplomas and certificates of fitness, signed by the proper authorities. There are examination fees of 30 marks, when three students come up at once, and 6 marks for each additional student. For the degrees of mining and metallurgical engineer, 75 marks are charged, and 60 marks if for one of these alone, *i.e.*, mining engineer or metallurgical engineer. The studies themselves comprise—(1) trigonometry, algebra, and geometry; (2) physics, practical physics, electricity, and mechanical theory of heat; (3) chemistry, theoretical chemistry, practical work in the chemical laboratory, chemical technology; (4) mineralogy, practical mineralogy, general geology, special and practical geology, and ore deposits; (5) elementary mechanics, higher mechanics, instruction in the construction of machines; (6) concentration of ores and mining; (7) surveying; (8) metallurgy and fuels—general metallurgy, special metallurgy, lectures on fuels and metallurgy of iron; (9) blowpipe analysis and assaying; (10) general jurisprudence—historical, Roman, Church, German and Prussian laws, private rights, State laws, German mining laws, general doctrines, ownership of mines, mining companies, miners' customs; (11) political economy—trade statistics and administration; (12) emergency lectures—physiology and anatomy of the human body and how to aid the injured (means, natural and artificial, general aid, aid in special cases, and transportation of the wounded). During the latest year for which returns are available it appears that of the total number of persons attending the Clausthal School, 110 were Germans, 18 English, 1 Dutch, 13 Americans, and 11 students whose nationality was not distinguished.

HOUSING OF THE WORKING CLASSES IN PARIS.

The city of Paris is not only one of the best governed cities in the world, says the United States Consul-General there, so far as police protection, the system of cleansing streets, and general municipal reforms are concerned, but the sanitary condition is of the best, and new laws are continually being made with the sole idea of perfecting the health and decreasing the death-rate. One great step in this direction is the recent enactment of a law regulating the construction and use of cheap tenement houses—dwellings for artisans. In all the large cities of the

world, one of the most dangerous and intolerable evils is the unsanitary condition of cheap tenement houses, where the very poor are compelled to live. Paris, perhaps, has fared better, as statistics will show, as regards morals, crime, health, &c., in cheap tenement dwellings, where two or three families reside, than any large city of the world. Until very recently, a law enacted during the first Republic in regard to the construction and use of cheap tenement houses for artisans has been in force. These buildings are divided into two distinct classes, and are under the strict control and supervision of the chief of police. One class is the cheap unfurnished apartments in which several families reside; the other is the cheap furnished apartment in which also a number of families live. A general board of health, emanating from the Prefecture of the Seine, which is called the *Bureau de la Salubrité générale*, exercises complete control over these buildings, so far as sanitary conditions are involved. When the latter are brought to the notice of the Board of Health, or whenever a complaint is made of some defect in the sanitary arrangement of any building that may be dangerous to the health of the inhabitants, or the city generally, the Board at once orders a thorough investigation, and steps are taken to remedy the evil.

The furnished tenement houses are placed under the supervision of a Board, known as *Bureau des Garnies*, which also emanates from the Prefecture of the Seine. Before anyone can let furnished rooms, a declaration must be made and filed with the bureau, stating that the building and rooms are in good sanitary condition. In addition to this, a medical inspector is sent to examine the building and rooms, to ascertain whether they can accommodate the number of people they are intended to receive, and whether, in a general way, they are in good sanitary condition. There is also connected with the Prefecture of Police a special medical department, called *La Salubrité*, which is only a part of the general health department. Upon the report made by the medical inspector in regard to the sanitary condition of any building furnished or unfurnished, the bureau gives or refuses permission to the proprietor to let his rooms. The first step therefore necessary for a landlord to take before he can let his rooms, is to procure a license or permit from the Board. It should be observed that, not only the cheap tenement houses, which are occupied by artisans and the poorer classes, are submitted to this inspection, but all furnished houses, hotels, &c. The highest as well as the lowest are submitted to a rigid inspection, and are under the active control of the *Bureau des Garnies*. For each and every apartment or furnished room that is let, there must be kept by the landlord a full and complete record of all arrivals and departures. Every other day an inspector calls at each house where furnished apartments and rooms are let to inspect the record kept, and inquire as to any events pertaining to the general sanitary condition within the past forty-eight hours in that particular house or neighbourhood. It has been a moot question whether this inspection should not take place daily instead of every two days, and only the question of increase of the number of inspectors, and therefore additional expense prevented the authorities from having the inspection made daily. There are no tenement houses constructed solely for the habitation of working men by the Government or municipal authorities, but a banking corporation in Paris, known as the *Banque d'Escompte*, has constructed certain tenement dwellings in a quarter of Paris known as the Buttes Chaumont, where manufactories and working establishments are situated, occupied solely by the working-classes. These tenement buildings, however, are of the better class, and are under the strict supervision of the municipal authorities, who closely inspect them as to their sanitary condition, &c. Each building contains a certain number of flats, or separate apartments, and are occupied by mechanics with their families. Formerly there were in Paris a number of establishments or houses where the unemployed could find a refuge at night for a trifling sum, but these have almost disappeared. Only two remain, situated in the neighbourhood of the great central market; but the Consul says they are more like eating houses than tenement houses. There are large rooms, however, holding from 200 to 300 people; and the homeless can procure, at a cost of about twopence, a bowl of soup, and a chair on which to sit throughout the night; no beds or coverings are furnished. These establishments, of course, are under the strictest police regulation, and under the most careful medical inspection. They are for both men and women, the sexes, however, occupying separate rooms. But few crimes have been committed, and the morality, generally, is considered good.

There are one or two charitable institutions in Paris, which are maintained by private subscription, and which are known as lodgings for workmen. One institution, known as the *Œuvre de l'Hospitalité de Nuit*, gives lodging to people out of work for three nights, free of charge. An institution of this character was founded in the suburbs of Paris by a lady named Foucault. She built small cottages adapted for the use of working people of the poorest class, principally rag-pickers, which has been of very great benefit. There are no statistics which show the death-rate, the number of illegitimate children, or of any crimes committed in any of the tenement houses occupied by the poorer class. Statistics do show, however, that the enactment of new laws and regulations which pertain to the general sanitary condition of Paris, tend to benefit the general health of the city, and reduce the death-rate. Until the adoption of a recent law passed by the Senate and the Chamber of Deputies, and signed by the President of the Republic in November, 1894, there had been no legislation on the subject of tenement houses and dwellings for working men in France for a number of years.

Journal of the Society of Arts.

No. 2,239. Vol. XLIII.

FRIDAY, OCTOBER 18, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

COMMERCIAL FIBRES.

By D. Morris, C.M.G., M.A., D.Sc., F.L S.,
Assistant-Director of the Royal Gardens, Kew.

Lecture III.—Delivered April 1, 1895.

IV. BRUSH AND MAT FIBRES.

Monkey Bass.

The hard, wiry palm-fibre obtained from *Leopoldinia Piassaba* is known as Para Piassava, or Monkey bass. The palm, when

Fif. 14.

Monkey Bass (*Leopoldinia Piassaba*).

Transverse section of a single strand of Monkey bass, apparently composed of three or more fibro-vascular bundles, coalesced together. The empty spaces represent the position of the vascular bundles. × 82.

fully grown, is about 20 to 30 feet high. The fronds or leaves are feather-winged or pinnate, with rather rigid leaflets. The plant is found abundantly, but less than formerly, in the Amazon basin, especially in Barra de Rio Negro. It grows generally as isolated specimens in dense tropical forests, but is found sometimes in patches of several trees together. It is nowhere cultivated. The dilated margins of the petioles, where they clasp the stem, are produced into long riband-like strips, which afterwards split into fine, somewhat round fibres, about 5 or 6 feet long, entirely concealing the stem. These fibres, cleaned and combed by hand, form the piassava of commerce. There is very little preparation necessary after the fibre is collected in the forest. It is used for making brooms and brushes. Owing to the discovery of other sources of piassava, and to the palms becoming scarcer in accessible situations, Para piassava at present forms only 4 or 5 per cent. of the total fibre found in commerce. Para piassava usually commands high prices.

Bahia Piassava.

A large, handsome palm, with pinnate leaves (*Attalea funifera*), abundant in the province of Bahia, Brazil, on river banks and moist situations, yields a fibre very similar to the Monkey bass of Para. The bases of the leaf-stalks separate into a long, coarse fringe, containing somewhat flat, flexible fibres. The trees grow wild, and no care is taken to preserve them. They are often cut down altogether in the young state for the convenience of getting the fibre. The latter is removed from the trees by means of a small axe. It is then "roughly heckled, straightened, cleaned, and made up into bundles of about 32½ pound each." The annual export from Bahia is about 7,000 tons, of the value of £117,664. Great Britain takes slightly more than one-half. The cost of the fibre delivered at Bahia is estimated at 5s. 7d. per arroba (32½ lbs.). The fruits of this palm are the Coquilla nuts of commerce, used for turnery purposes. An interesting account of Bahia piassava is given by Mr. W. S. Booth in the "Kew Bulletin," 1889, pp. 237-242.

Madagascar Piassava.

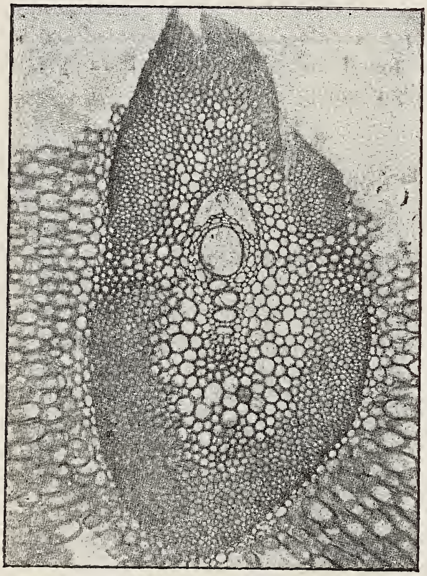
For many years a long, fine fibre, of a rich brown colour, has been obtained from Madagascar, closely resembling Para piassava. The plant was only determined last year, when it was described in the "Kew Bulletin," 1894, p. 358. It is *Dictyosperma fibrosum*, known locally as *Vonitra*. The fibre is finer and more flexible than Brazilian piassava.

The quantity received in this country has always been limited, and latterly it has almost entirely disappeared. The high quality may be gathered from the fact that the last prices paid were £46 6s. per ton, with "good to prime" Bahia at £40 to £50 per ton, and "good" Palmyra at £30 to £40 per ton. When well cleaned, Madagascar piassava took rank as a first-class brush fibre.

West African Bass.

In 1890, Sir Alfred Moloney, then Governor of Lagos, drew attention to the possibility of obtaining a fibre from the bamboo or wine palm of West Africa. This is *Raphia vinifera*

Fig. 15.



West African Bass (*Raphia vinifera*).

Transverse section of a single fibro-vascular bundle of West African Bass, partly embedded in cellular tissue. The vascular portion in the centre occupies a large proportion of the area, and thereby tends to weaken the character of the fibre. × 50.

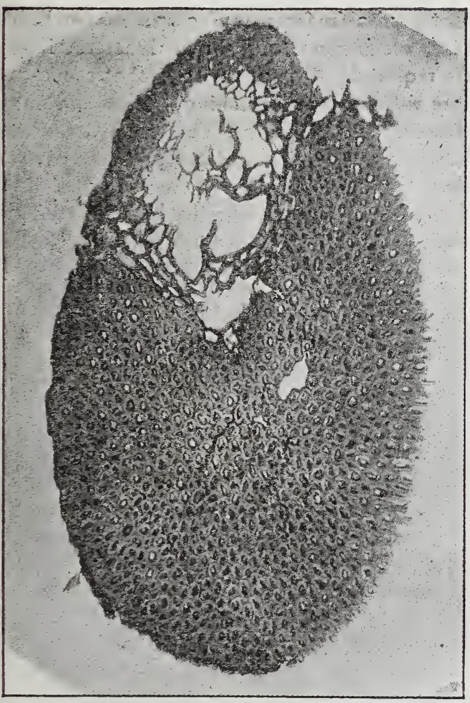
(already mentioned as likely to yield epidermal strips similar to Madagascar Raffia). The bamboo palm extends throughout many parts of West Africa. In Lagos alone it is estimated that it forms a considerable proportion of the forest vegetation over an area of 5,000 square miles. The fibre is obtained from the fibrous sheathing at the base of the petioles. It is readily obtained in lengths of 3 to 4 feet; the diameter of the individual fibres as found in commerce is from $\frac{1}{16}$th to $\frac{1}{30}$th of an inch. To understand the mode of occurrence of the fibre, the following is taken from Sir Alfred Moloney's account, published in the "Kew Bulletin," 1891, p. 4:—"When the leaves are cut away from the lower part of the palm, portions of the leaf-stalk are left adhering to it. These leaf-stalks encase the trunk, and project upwards and outwards, forming *chevaux de frise* all round it. From the fibre in these stumps the native fishing lines are made. It is extracted by simple soaking in water, and scraping. The process is very simple, and fully understood by the natives. It is the stronger portions of this fibre which are exported as West African bass." The Governor adds, "There is no reason why, with a population in the habit of preparing it, and a source of supply which may be regarded as practically unlimited, we should not be able to compete on even terms with the sources of supply which at present monopolise the market." Since 1890, West African bass has become a regular article of commerce. The prices are usually below Para and Bahia fibres. At the beginning of 1895 "the arrivals were heavy; prices £12 to £26 per ton."

Palmyra Fibre.

A fibre very similar to West African bass, and nearly of the same character as Para and Bahia piassava, is obtained from the Palmyra palm, called by the Portuguese, *par excellence*, "palmeira," or "the palm tree" (*Borassus flabellifer*). In West Africa it is known as the Black Run palm. It is very tall, sometimes, but very rarely, branched, with large, fan-shaped leaves with spinous petioles. The fruit is nearly as large as a cocoa-nut, with one to three seeds. The Palmyra palm is widely distributed in India and Ceylon, but generally in a cultivated state. It is, however, truly wild in tropical Africa. In the East, it is a toddy or sugar palm. The young germinating nuts are cooked and eaten as a vegetable. The leaves are made into books, which contain the classics of the Pali and Singhalese languages. The timber is hard, and very durable; it is used for umbrella handles and walking-sticks. From the base of the petioles, or the sheathing leaf-stalks, is obtained a stiff, wiry fibre. This was at first called "bassine," to distinguish it from bass and piassava fibres. It came into notice as a commercial article in 1891, when the high prices of piassava induced the production of substitutes. At that time even split rattan, stained black, was requisitioned as a brush fibre. Palmyra fibre has steadily increased in quantity, and, contrary to what was

at first anticipated, it has also risen in value. "The chief objection to Palmyra," wrote Messrs. Ide and Christle, in 1892, "is that it lacks straightness, but experiments are being made in this country to overcome this defect, and should they prove successful it is claimed by importers and dressers that Palmyra should, for wear, be found equal to the best Para." These anticipations have, to some extent, been realised. Palmyra now has practically taken the place of West African bass. The latter, on the 16th Sept., 1895, was "dull, business small, £14 to £23 per ton." Palmyra fibre, on the other hand, was "good, £26 to £34; medium, £22 to £25; common, £15 to £19 per ton."

FIG. 16.



PALMYRA FIBRE (*Borassus flabelifer*)

Transverse section of a single fibro-vascular bundle of Palmyra fibre. The vascular area is small, hence the greater strength of the bundle. The fibre cells are densely compacted, very numerous, and with thick walls. The durable character of Palmyra fibre is therefore evident. × 82.

The natives in Ceylon and India are evidently copying the worst practices of the Indians of Brazil in sending consignments of Palmyra fibre to this country in a damp condition. The result is that, as one firm complains," the bales, on opening, are found wet, and the fibre to a large extent perished and powdery." Should the practice continue, the industry will be seriously injured. The bales are press-packed, and iron bound; they weigh 1 to 3 cwts., and measure 10 to 30 cubic feet."

KITTOOL FIBRE.

The Kittool or Kittul palm of India and Ceylon (*Caryota urens*) is a stout handsome plant with a smooth annulated stem, 30 to 40 feet high. It has broad leaves, with the leaflets obliquely cuneate. The fruit is small and reddish. It is a toddy and sugar palm, and also yields sago.

Mr. J. R. Jackson, A.L.S., in "Commercial Botany," gives the following excellent account of the fibre yielded at the bases of the leaves of this plant:—"Kittool fibre," he says, "has been known in this country for some 30 or 40 years, but it is within the last 10 years that it has become a regular commercial article. When first imported, the finer fibres were used for mixing with horse-hair for stuffing cushions. As the fibre is imported, it is of a dusky-brown colour; but after it arrives here it is cleaned, combed, and arranged in long straight fibres, after which it is steeped in linseed oil to make it more pliable; this also has the effect of darkening it, and it becomes, indeed, almost black. It is softer and more pliable than piassava, and can consequently be used either alone or mixed with bristles in making soft, long-handled brooms, which are extremely durable, and can be sold at about a third the price of ordinary hair brooms."

The use of Kittool fibre is said to be spreading not only in this country, but also on the Continent. During 1895, Kittool fibre has not been much in demand. The values on the 16th September were quoted as follows:—"Long, 10d. to 10½d.; No. 1, 7d. to 7½d.; No. 2, 2d. to 2½d.; No. 3, 1d. to 1½d. per lb."

EJOO, OR GOMOTU FIBRE.

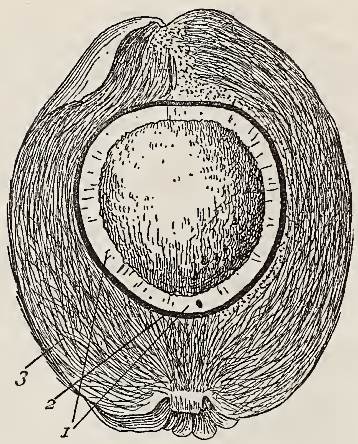
An erect palm, with pinnate leaves, the sago palm of Malacca (*Arenga saccharifera*), is found plentifully in Burma and the far East. At the base of the petiole is found a beautiful black fibre, known as Ejoo, or Gomotu fibre. There are several qualities: the coarsest is only fit for brush-making; the medium qualities closely resemble black horse-hair, and make excellent ropes and cables; the finest are used for caulking ships, stuffing cushions, and as tinder. Ejoo fibre is extensively used in the East. It undergoes no preparation, either before or after being twisted into ropes. It is remarkable for quality and cheapness, and is so durable

under water, that it has been recommended as a covering for telegraph cables.

Cocoa-nut Fibres.

The Cocoa-nut palm (*Cocos nucifera*) is extensively cultivated in nearly all tropical countries. It exists in immense groves in Southern India, Ceylon, the Islands of the Eastern Archipelago, and Polynesia. Its cultivation is extending in the West Indies, and on the East and West Coasts of tropical Africa. The cocoa-nut palm is one of the first objects to be seen along the beach, and soon becomes one of the most familiar objects to travellers in the tropics. It is a valuable

Fig. 17.



Cocoa-nut (*Cocos nucifera*).

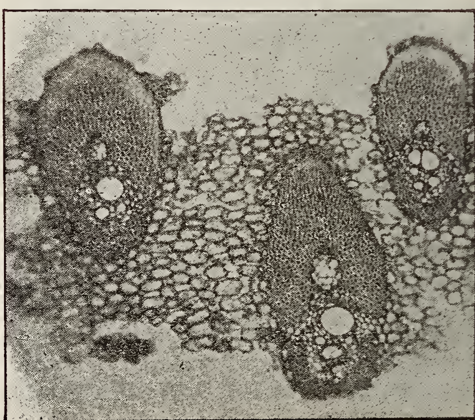
Vertical section through the fruit of a cocoa-nut palm. The central cavity contains the milk. 1, the white albumen or flesh of the cocoa-nut; 2, the endocarp or brown, hard, bony shell; 3, the pericarp forming the fibrous covering or husk of the cocoa-nut; this yields the coir of commerce. At the termination of the lower line 1 is the embryo pointed towards the base of the fruit. [In planting the cocoa-nut in the nursery it is, therefore, necessary to place it with the basal or stalk-end uppermost.] $\frac{1}{8}$ n.s.

food plant for man and animals, and provides besides materials for the construction of houses, and numerous utensils in daily use. It has a cylindrical stem, usually gracefully curved, and attaining a height of 40 to 100 feet, surmounted with a crown of large feathery leaves. The plant is propagated by means of seed-nuts (the fruit); these germinate, if kept moist, in 3 to 5 months. The young plants are put out in their permanent places, when about 8 to 15 months old, at distances varying from 27 to 33 feet apart. The cocoa-nut begins to bear in 5 to 8 years. Usually, the nuts take from 8 to 10 months to mature before they fall from the parent plant. Each cocoa-nut palm bears from 30 to 60, and, very exceptionally, when well watered and manured, up to 100 nuts a year.

As shown above, the coir of commerce is yielded by the thick pericarp or outer fibrous covering of the fruit of the cocoa-nut palm. The word "coir" is said to come from the Malay *Kāyar*, a twisted product. Kayer is also the Tamil for a rope. Although coir was known in Europe in the 16th century, it was not until about 1842 that it was brought prominently into notice. St. George's-hall, Windsor, in that year was laid with cocoa-nut matting on the occasion of the baptism of the Prince of Wales. Later a great impetus was given to coir manufacture by the Great International Exhibition of 1851.

Cocoa-nut fibre is tough, elastic, easily manipulated within certain limits, and eminently suitable for manufactures where lightness, cleanliness, and great indestructibility are required. It is understood that cocoa-nut fibre will not bear bleaching. Various shades of colour are, however, obtainable by using different descriptions of natural unbleached fibre. In an ornamental mat in the Kew Museum the various shades are obtained by using dark Fiji coir, medium coloured Ceylon coir, and very light Cochin coir.

Fig. 18.



Cocoa-nut (*Cocos nucifera*).

Transverse section through a portion of the fibrous husk (pericarp) of the cocoa-nut. Three fibro-vascular bundles are shown embedded in cellular tissue. Each bundle represents a single fibre of coir when thoroughly isolated from the cellular tissue. There is a considerable resemblance in character, but not in size, between the fibro-vascular bundles in the husk of the cocoa-nut and those in the petioles of the Palmyra palm (Fig. 15). Hence, probably, the durable character of the latter. × 50.

Besides being made into rough cordage, coir is used in combination with wool to give richness and effect to hearth-rugs and carpet-

ing. It is also used for brushes and brooms for household and stable purposes, matting for sheep-folds, pheasantries and poultry yards, church cushions and hassocks, hammocks, clothes-lines, cordage of all sorts, string for nurserymen, nosebags for horses, mats and bags for seed-crushers, oil pressers, and candle manufacturers. Coir is one of the best materials for cables, on account of its lightness, elasticity, and strength. It is durable, and little affected by salt water. Of coir and coir-made rope, about 9,000,000 to 10,000,000 lbs. are annually shipped from India; much is prepared in Ceylon; but Cochin is noted as the port of shipment for the best quality of yarns.

Certain varieties or cultivated forms of the cocoa-nut are better suited than others for the production of coir. Cochin (a small native state on the Malabar coast) produces a bright, light-coloured coir, which fetches the best price. On the other hand, a good deal depends on the age at which the nuts are gathered, and the time which elapses before they are husked and cleaned.

In the process of separating the fibre, the following commercial qualities are produced: —The mat, or long fibres, used for spinning purposes; the shorter, or more stubborn fibres (bristles), for brooms or brushes; the tow or curled fibre for stuffing cushions; and the dust or refuse for gardening purposes. When dyed black, the tow has been used as a substitute for horse-hair. A singular use was proposed a short time ago for cocoa-nut dust or refuse. Taken before it is quite dry, and subjected to great pressure, it is capable of forming plates of varying thickness, like mill-board, only much more brittle. These boards, if used as backing for steel plates of ironclads, swell up on being punctured below the water-line, and soon close the orifice. If really effective, such plates could be produced at a trifling cost, for thousands of tons of cocoa-nut refuse float away annually down the rivers in India and elsewhere.

The first step in the preparation of coir is the removal of the husk from the hard interior shell. This is usually done by striking the nut on a pointed instrument stuck in the ground. A man can husk about 1,000 a day. The husks are then soaked in water. This is variously conducted. The water may be either salt, brackish, or fresh; in this the husks are kept for a lengthened period. The more recent method is to place them in tanks of water made warm with steam. The latter hastens the softening process, and improves the colour and quality of the fibre. Where machinery is used, the husks, when sufficiently soaked, are passed through a crushing mill, which flattens and crushes them ready for the extractor, or breaking-down machine. In the latter the fibres are completely disintegrated, and are then passed through a "willowing" machine, to free them from dust and refuse. It is calculated that, when treated in this country, 10,000 husks will produce 45 to 50 cwt. of "spinning fibre," and 9 to 13 cwt. of "brush fibre."

In Ceylon, 40 cocoa-nuts are said to yield 6 lbs. of coir; in Madras, 3 large coast nuts yield 1 lb. of coir; in the Laccadives it requires 10 small nuts to yield a pound of coir, measuring, when made into yarn, 35 fathoms. In 1889, an attempt was made to export coir from Lagos. A bale of loose coir, weighing 42 lbs., was prepared from 400 nuts. No attempt had been made to separate the "bristle" and "mat" fibres. Good Ceylon bristle fibre was then worth £30 per ton, and Ceylon mat fibre £10. The Lagos fibre, when separated, was valued at £15 and £9 to £10 respectively ("Kew Bulletin," 1889, pp. 122-132). The average annual value of coir goods exported from Ceylon is put down at £60,000. The quantity exported in 1884 was as follows:—Coir rope, 10,419 cwt.; coir yarn, 84,057 cwt.; coir fibre, 12,732 cwt.; total, 107,208 cwt.

The principal exports of coir from India are from the Madras Presidency. For the five years ending 1880-81 they were 271,934 cwt., valued at Rs. 2,179,767, while for the year 1881-82 the value was Rs. 2,354,202. The exports from the Malabar coast alone amounted to Rs. 2,243,000. "From these figures an idea may be obtained of the immense importance of Malabar aud the Laccadives as the chief seats of the Indian coir industry."

The approximate market value per ton of coir goods in London on the 16th September, 1895, were as follows:—

Coir yarn: Cochin, common to good, roping, £11 10s. to £14, weaving, fair to good, £20 to £25; Ceylon, fair to good, ballots and bales, £17 to £21.

Coir fibre: Cochin, fair to good, £14 to £20; Ceylon, clean, £8 to £9 10s.

Coir rope: 4½ to 6 inch, 2½ to 3½ inch, and 1½ to 1¾ inch, £11 to £14.

Bristle fibre: Medium, £18 to £21; good, £29 to £30.

Black Curled Fibre.

The only palm native of Europe is the Dwarf Fan Palm (*Chamærops humilis*). This is the French *Palmier de Nain*. It is very abundant in North Africa, and particularly in the departments of Algiers and Oran. It forms extensive thickets in the dry alluvial soils of the littoral, and is very difficult to eradicate in any land where it is established. Once regarded as a troublesome and useless plant, it has of late years become a source of profit and commerce. The leaves furnish 50 per cent. of fibre, which is extensively used as a cheap substitute for horse-hair. A man can cut about 400 lbs. of green leaves per day. The fibre is extracted either by combing by hand or by means of drums with needles and knives worked by steam-power. The "green" fibre is twisted or curled in its raw state, and finds several applications. The "black" fibre is first dyed in baths of sulphate of iron and logwood; it is then twisted and again dyed. The local name is *crin végétal*. This fibre is said to possess two advantages over animal fibre, and these have led to its extensive employment. It is exempt from insect destruction, and 75 per cent. cheaper than horse-hair. There are large works in Algeria where the leaves are brought in large quantities, and the fibre cleaned on an extensive scale. "In Oran one factory prepares daily 60 bales of 2 cwt. each." In another, "by a particular process, a firm prepares black and brilliant *crin végétal*, without smell or dust, at the rate of 1,000 cwts. per month." The fibre is consumed principally in France, England, Germany, and the United States.

"The quantity of this vegetable hair shipped from Algiers in 1872 was 2,394,000 kilos. In 1887 the exports were as much as 15,304,126 kilos, valued at £88,900." The price of "black curled" fibre on the 16th September, 1895, was 9s. 6d. per cwt.; of "green," 6s. per cwt.

Spanish Moss.

Another "vegetable hair," more commonly known in the Southern States of America as Spanish moss, is obtained from a delicate, mossy-looking plant (*Tillandsia usneoides*), belonging to the pineapple family. This grows as an epiphyte on trees in tropical and sub-tropical parts of South America, the West Indies, and the Southern United States bordering on the Gulf of Mexico. In the West Indies it is called the "Old Man's Beard." The plant hangs in loose, lace-like masses on the branches and stems of several kinds of trees. The largest and most tenacious is said to be gathered from the cypress (*Taxodium distichum*). It gives these quite a funereal aspect. A living plant of this *Tillandsia* suspended from a dry block, and apparently deriving all its nourishment from the atmosphere, may be seen in the Tropical Stove (No. 9) at Kew. The "moss" is gathered in the Southern United States by negroes, who afterwards sell it to the factories, where it is cleaned and made into fibre. The single thread or fibre contained in the stem and leaves of this interesting plant is tough and black, almost identical with horse-hair. The fibre is prepared by soaking the plants in water until the cuticle of the leaf has decayed. It is then boiled in water, and washed until the black fibre is perfectly clean and glossy. It may also be prepared by simply burying the moss in earth for two or three weeks, and then washing in water. When well prepared, this fibre is not only frequently used instead of horse-hair, but is almost indistinguishable from it. It is largely used for stuffing purposes. The head-quarters of the industry is at New Orleans.

Pine Wool.

A brown elastic fibre is prepared in Germany, and in some parts of the United States, from the leaves of pine trees. In Germany, the leaves are obtained partly from what is known in this country as the Scotch Fir (*Pinus sylvestris*), and partly from the Corsican Pine (*P. Laricio*). In the United States the leaves of the Long-leaved or Resin Pine (*Pinus palustris*) are chiefly used. The industry was started at Breslau about thirty years ago. The pine leaves are collected in the fresh state and delivered at the factory at a fixed price per cwt. They are spread out and carefully picked over to get rid of portions of twigs and bark. They are then placed in a still with water to extract the oil, which forms an important item in the industry. This oil has the characteristic odour of pines. It is at first green, then yellow. There is a considerable demand for pine oil in commerce. The leaves, when removed from the still, are boiled with alkalis, broken in a "rubber," and dried. The fibre is then curled, passed through carding machines, and once more dried. The yield of "pine wool" is 13 per cent. of the weight of the green leaves. True "pine

wool" is said to retain the odour of the pine, is soft in texture, elastic, and durable. It is recommended as a surgical dressing; the finer sorts are used for making wearing apparel and blankets, and the coarser for carpets or mats.

A good deal of the material advertised as "pine wool," "fir-tree wool," and "pine forest wool," has been proved to be nothing more than cotton or sheep's wool stained of a brown colour to resemble the genuine article.

V. PAPER-MAKING FIBRES.

Paper-making depends entirely on vegetable fibres for the supply of cellulose, which is the essential element in all papers. Without cellulose there could be no paper. Paper is the result of felting together in the wet state of fibre cells obtained from the bast of exogens, and the fibro-vascular bundles of endogens, already described. In treating material for paper-making, the object of the paper-maker is to get rid of a portion or of all the extraneous substances other than pure fibre; the solvent for such extraneous matters may be cold or hot water with alkaloids or acids, with or without pressure; and according to the degree to which the ultimate fibre has been purified of extraneous matters, the better it bleaches, and the better the colour and quality of the paper produced from it.

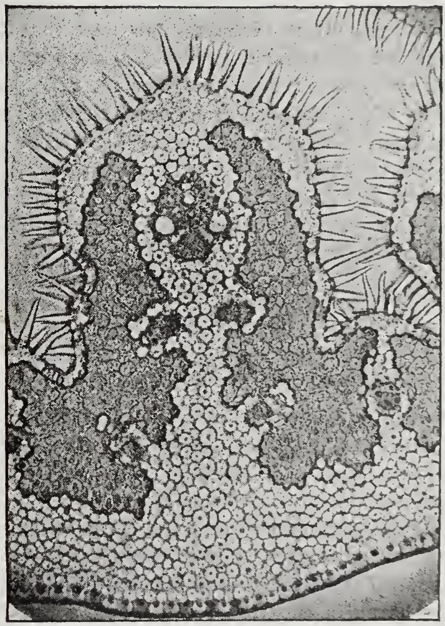
The quantity of paper produced annually in Europe is estimated at 1,000,000 tons, of the value of £30,000,000; of this sum one-half is the cost of the raw material.

The vegetable substances from which paper can be made are very numerous. The difficulty is to find a substance at once cheap enough to be used profitably, and abundant enough to secure a continuous supply. About 20 years ago, paper materials were becoming so scarce that the whole world was searched for them. Bamboos, straw, wild grasses, banana-stems, the rejections of spinning and weaving industries, torn and waste, jute butts, rags and cuttings of all kinds were utilised. No woollen goods nor any animal fibres, as they contain no cellulose in an appreciable quantity, could be used for paper-making. As showing the diversity of the material from which paper could be made, "a paper maker at the Paris Exhibition showed more than 60 webs or rolls of paper, each made from a different vegetable fibre." At the present time only two have come into use to a large extent; these are esparto and wood-pulp. Cotton and linen rags are regarded as very important, if not the most important, materials for paper-making purposes. They can, however, only be used profitably in the best papers. Cheap papers are largely made of mechanical wood pulp, mixed with kaolin or china clay. Such papers have no durability, and are quite unsuitable for bookwork.

ESPARTO.*

The esparto is a tufted grass (*Stipa tenacissima*) allied to the ornamental feather-grass. The leaf sheaths are hairy internally, and hence esparto can be easily distinguished from a somewhat similar, but inferior grass (*Albardin*), formerly introduced instead of the genuine article. Esparto grows in dense clumps, with the culms from 1½ to 2½ feet high. It thrives extremely well in sandy and rocky soils, at moderate elevations, near the sea coast. It is abundant in North Africa, and in some localities of Southern Spain. The plants are growing wild over extensive tracts of country, and the only expense is, practically, the cost of collecting and shipment.

FIG. 19.



ESPARTO (*Stipa tenacissima*).

Transverse section of a portion of a leaf of esparto, showing one of the projecting ribs on the inner side with a bay on either side, all armed with silicious hairs. The darker areas are the chlorophyll-bearing cells. The whole of the lighter portions occupying the lower part of the field, and extending upwards between the chlorophyll-bearing cells are the thick-walled fibre cells. × 150.

* The Spanish form of *sparton*, cordage.

From very ancient times esparto was used for making carpets, ropes, baskets, nets, and as a substitute for horse-hair. These were prepared from the long leaves grown inland, now not considered so good for paper-making as those growing near the sea coast.

The harvest of esparto commences in August and lasts up to October. About 10 tons of dry esparto may exceptionally be obtained from one acre. The four sorts of commercial esparto are named after the country of origin. The Spanish is regarded as the best, then come the Algerian and Tunisian, and lastly the Tripoli esparto. A small quantity occasionally comes from Morocco. Spain for a long time supplied the whole of the esparto of commerce, but latterly its exports are small compared with those of North Africa. The area under wild esparto in Algiers is estimated at 2,500,000 acres, but a good deal is beyond reach or facilities for transport to the coast.

The extensive use of esparto for paper-making is greatly due to the exertions of the late Mr. T. Routledge. He commenced with a few tons at the Eynsham mills, about 40 years ago. It is of interest to note that the paper for the number of the *Journal of the Society of Arts* for November 28, 1856, was made of it. The use of esparto extended very gradually. The annual value has, however, of late reached nearly a million sterling. The United Kingdom has, hitherto, monopolised the supply. The imports for the last thirty years have been as follows:—

1861	891 tons.
1870	89,156 „
1880	191,229 „
1890	217,078 „

The highest imports were in 1888, when they reached 248,836 tons. Since 1890, the imports have somewhat declined. Last year, 1894, they were only 184,910 tons.

There is apparently a disposition, except in Scotland, to give up the use of esparto in favour of the cheaper and inferior wood-pulps. The fibres in esparto are easily dissolved and bleached. An authority on paper-making writes:—"They felt readily, and yield an excellent pulp, which is employed alone or mixed with rags, wood-pulp, or straw. They furnish a paper pliant, resistant, transparent, and of great purity; thicker than other papers of the same weight, and forming a good printing and writing substance." The falling away in the use of esparto for paper-making, and the substitution of cheap paper-pulps, must therefore be regarded as likely to lower the general quality of English-made paper.

The following Table will show the comparative value of esparto in 1878 and 1895 respectively. The great falling off in prices of late years is due, as suggested, to the competition of wood-pulp. The figures are compiled from the circulars issued by Messrs. Ide and Christie, 72, Mark-lane, E.C.:—

Quality.	Price per Ton. 1878.	Price per Ton. 1895.
	£ s.	£ s. d.
Spanish, fine to best, average ...	10 5	5 2 6
„ fair to good, „	10 0	4 12 6
Algerian—		
Oran, first quality, „	7 10	3 12 6
„ fair to good, „	7 0	3 2 6
Tripoli, hand-picked, „	6 10	3 9 6
„ fair average, „	6 0	3 5 0

Bhabur Grass.

Bhabur grass (*Ischæmum angustifolium*) might be regarded as the esparto of India. It closely approaches the latter in habit and in the technical qualities necessary for paper manufacture. The late Mr. Routledge tried Bhabur in 1878. His opinion was favourable:—"A small quantity of bleach," he said, "brings it up to a good colour. The ultimate fibre is very fine and delicate; rather more so than esparto, and about the same strength; the yield, however, is 42 per cent., somewhat less. . . . I may venture to say that it will make a quality of paper equal to esparto." Since 1878 Bhabur grass has become very largely used in India. At the present time it affords—as stated by Dr. King, F.R.S., who first called attention to it—"the chief raw material for paper-making in the neighbourhood of Calcutta and other parts of India." The grass is very common in the Siwalik range and in the Bhabur forests of the Gharwal and Kumaon Himalaya. It is found in the forests of Chota Nagpur. The prospect of utilising the grass would be, no doubt, improved if it were cultivated. This is readily practicable. It yields at present two crops in the year, one in September, and the other in October or early in November. It might yield a third if irrigated. ("Kew Bulletin," 1888, pp. 157-160, with plate.)

Straw.

Although, properly speaking, it is the straw of esparto that is used for paper-making, it is so superior for this purpose to ordinary straw, that it deserves to stand alone. The straw of numerous cereal grasses is employed where obtainable: rice straw is used in Asia; wheat, oat, and other kinds in Europe. "For low papers straw commands a market, but as a mixer it is inferior to esparto, the internodes or knots being exceedingly troublesome, and difficult to get rid of."

Wood-pulp.

The deficiency in paper materials led to the use of pulp, made from the wood of certain trees. The woody stems of trees are composed of (1) vessels or long continuous tubes with peculiar markings, due to the walls being unequally thickened; (2) fibrous cells composed of long, thick-walled cells with sharply-pointed ends, the wall is thickened nearly all over, but there are a few narrow pits where the wall is left thin; (3) of woody parenchyma having cells with square ends with rather thick walls and small pits. The woody character of the fibrous cells is due to the presence of lignine. This renders them much harder and stiffer than those of pure cellulose, as found in cotton. In the manufacture of wood-pulp the object is to break up and reduce the wood cells so as to form a suitable material for paper-making. Mechanical wood-pulp is prepared by merely grinding the wood of certain trees, such as poplar, aspen, spruce, and fir, into a fine creamy condition, and afterwards washing out some of the impurities with water. There is still left a large amount of lignine and other substances which are injurious to the quality of the paper. Mechanical wood-pulp is often of sufficient whiteness to be used for what are called white papers, but such papers become discoloured with age, and perish on exposure to a damp atmosphere. Wurster has devised a test based on the depth of colour given by these papers, so that he can arrive at a quantitative estimation of the proportion of mechanical wood-pulp contained in them. Chemical wood-pulp is produced by treating the ground wood with chemicals to remove the resin, and all ligneous and mineral deposits, leaving only the fibrous cells composed of almost pure cellulose. The various sorts of chemical wood-pulp (often called wood cellulose) are named according to the chemical agents employed in their manufacture. These may be *sulphite* pulp, *soda* pulp, or *sulphate* pulp, according as they are prepared either with sulphite of lime, caustic soda, or sulphate of soda. The Common Spruce and the Silver Fir are the chief species that supply the chemical wood-pulp of Europe, while the White Spruce, Black Spruce, Canadian Hemlock, White American Pine, and Silver Fir, furnish the chemical wood-pulp of the United States and Canada.

The rapid progress made in the use of wood-pulp for paper-making is one of the most remarkable amongst modern enterprises. In the United States, in 1886, only about 97,000 tons were produced. During 1894 the quantity was estimated to exceed a million tons of the value of £5,000,000. Mr. S. P. Eastick states tha the pulp necessary for the daily editions of one New York paper absorbs the timber from about seven acres of an average forest. Although at first only intended for paper-making, wood-pulp is capable of being so hardened that it can be successfully employed for the manufacture of furniture, carriages, floor-covering, kitchen utensils, &c. It can also be dyed any colour and rendered fire and water-proof.

The most suitable wood for the manufacture of chemical wood-pulp is derived from the *Coniferæ*. Hence the pine forests of the United States and Canada, as well as those of Europe, have considerably increased in value. In many cases the small logs and waste of saw-mills can be utilised for wood-pulp. Sawdust has been found unsuitable, owing to the difficulty of treating it effectually. Canada is very advantageously placed for a wood-pulp industry. It possesses, as one authority states, "vast forests of suitable wood, whose quality cannot be surpassed; it has magnificent rivers for transporting logs and produce, and enjoys the advantage of numerous sea-ports and low ocean freights to Europe."

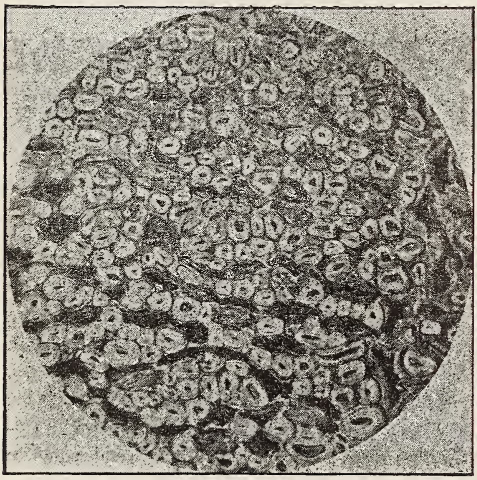
Norway and Sweden take the lead in the wood-pulp industry of the Old World. The estimated exports of mechanical wood-pulp for 1894 were about 240,000 tons of the value of £500,000. This is nearly double what it was six years ago. There were 61 machine wood-pulp factories, of which three were attached to cardboard factories, and ten to paper factories. A large quantity of the Norwegian wood-pulp is shipped to the United Kingdom, but France and Germany also take increasing quantities. In the preparation of chemical wood-pulp or cellulose there were ten turning out sulphite pulp, and four turning out soda pulp. The exportation in 1894 were about

34,000 tons of dry, and 10,000 tons of moist pulp, against 32,000 tons of dry and 13,000 tons of moist in 1893. The annual value of the chemical wood-pulp industry is about £320,000. A large proportion of this pulp is shipped to the United States.

Nepal Paper Plants.

Although, at present, there is little prospect of any paper material competing successfully with wood-pulp, it is desirable to mention a few fibres that possess exceptional merit. Of these, the most prominent in India is the Nepal paper plant, *Daphne cannabina* (also known as D. papyrifera). This is a shrub or small

Fig. 20.



Nepal Paper Plant (*Daphne cannabina*).

Transverse section through the bast area, showing the characteristic disposition of the fibre bundles. The cells vary in diameter, in thickness of the wall, and size of cavity. × 150.

tree found on the Himalaya, between altitudes of 3,000 and 10,000 feet, on the Khasia and Nage hills, and it is one of the most abundant bushes on the hills between Manipur and Burma. It is said that the well-known Nepal paper is made from the bast fibre of this and other species of *Daphne*, and of the allied *Edgeworthia Gardneri*. Dr. Royle states that, at the Exhibition of 1851, a sample of Nepal paper was shown of such size as to occasion universal surprise. He states:—"This paper is remarkable for its toughness, as well as its smoothness." An engraver, who tried some of this paper, stated that "it afforded finer impressions than any English-made paper, and nearly as good as the fine Chinese paper which is employed for what are called India paper proofs." As Daphne paper can be purchased throughout India, it is evident that the manufacture of it by the hill tribes, who alone produce it in quantity, must be very extensive. Dr. Watts remarks, "Daphne paper will endure for many years under a treatment that, in a few weeks, days, or even hours, would render the modern papers produced in England perfectly worthless."

Paper Mulberry.

The Paper Mulberry (*Bronssonetia papyrifera*) is widely distributed throughout Eastern Asia and Polynesia. It is extensively used for making paper and also the Tapa cloth of the South Sea Islands. The Japanese propagate the plant very much as willows are grown in England. They use only the young shoots for the manufacture of paper. Mr. Routledge stated that the bast of the Paper Mulberry was nearly, if not quite, the best fibre he had ever seen. It required very little chemicals and gave an excellent yield—62·5 per cent. in the grey and 58 per cent. bleached. The Japanese use paper made from this plant for a variety of purposes, such as umbrellas, lanterns, and books of all kinds. In the Kew Museum is a specimen of Tapa cloth, originally part of a roll that measured two miles in length by 120 feet wide. This belonged to the King of Tongataboo, one of the Friendly Islands. A paper very similar to that prepared from the Paper Mulberry is obtained in Siam from *Streblus asper*. This is a weedy-looking tree abundantly distributed throughout India, Ceylon, and tropical Asia. White Streblus paper is used for legal documents and Government correspondence, while a black paper written upon with talc is used for rough drafts and for taking evidence in native law courts ("Kew Bulletin," 1888, pp. 81-84).

VI. CELLULOSE INDUSTRIES.

In concluding these lectures, it is desirable to say a few words on the industrial application of cellulose other than for fibre purposes. We started by regarding cellulose as the essential element in all fibres. We have seen, in the course of our inquiry, that the larger the per-centage of cellulose the better the fibre. It is not too much to say, in regard to the manifold uses to which cellulose can be put, that it is one of the most important bodies in the whole realm of Nature. The most abundant and accessible form of pure cellulose is the floss of cotton and the silky seed hairs of many plants described in the first

lecture. It is also found almost pure in well-bleached fabrics made of linen, hemp, and in the best, unsized, white paper. The use of cellulose, now to be dealt with, is based on the facility with which it can be dissolved or gelatinised in the presence of certain metallic compounds, or by means of nitric and sulphuric acids. By means of the latter, it yields the cellulose nitrates which find a number of highly important uses in explosives, such as gun-cotton, and when associated with nitro-glycerine in the newer explosives known as blasting gelatine, ballastite, and cordite. Schultze Powder is prepared by macerating soft timber until only pure cellulose remains. This is nitrated with acids, and forms a powerful powder that is almost smokeless. Other nitrates of cellulose are worked up with camphor and similar substances into celluloid and xylonite, forming plastic masses which can be cut and moulded into articles of the most varied form and use. Besides these there is collodion (pyroxylin), a nitrate of cellulose dissolved in ether-alcohol, forming transparent solutions, which, on evaporation, leave a film of considerable elasticity and tenacity. There are surgical or medicated collodions and photographic collodions. The cupra-ammonium solutions of cellulose are utilised in the production of what are known as "Wllesden" goods. "Vegetable textile fabrics, when passed through a bath of the cupra-ammonium hydroxide are 'surfaced' by a film of gelatinised cellulose, which retains the copper oxide in such a way that it dries of a bright 'malachite' green colour. By this treatment the fibres are further compacted together, and the fibre acquires a water-resistant character. The presence of the copper oxide is also a preservative against the attacks of mildew, insects, &c. If the fabrics are rolled or pressed when in the gelatinised condition, they become firmly welded together on drying, and a variety of compound textures are produced in this way." (Cross and Bevan, *Cellulose*, p. 13.)

Another application of soluble cellulose is the product known as artificial silk. This is prepared by means of an apparatus which allows the soluble cellulose to be drawn off from the end of a glass tube on to a light wheel revolving at a definite rate. By this means the thread is kept continuously at a uniform diameter. Several threads being twisted together in the usual way of "silk-throwing," the artificial textile thread is produced. "Artificial silk has been found to have a tensile strength equal to 70 per cent. of that of the natural product of the same degree of fineness." It is capable of being largely used industrially.

Viscose is the commercial name given to an acetate solution of cellulose likely to prove of great value. A series of preparations of viscose shown before the Society of Arts indicated varied uses for this substance. In the dry condition it is of a horny character, extremely hard, and very durable. In thin sheets it can be used for book-binding and resembles the finest parchment. In solution it can be used to size paper and give a fine durable coating to jute and hemp goods, preserving them from the deteriorating influences of a damp atmosphere. Viscose also gives a good surface appearance to cotton goods and at the same time adds greatly to their strength.

Miscellaneous.

COMMERCIAL FIRMS AND FACTORIES IN JAPAN.

A statement has recently been published by the authorities in Japan, showing the date of origin and the number of firms and companies in that country, and the nature of their business. The total number at the end of 1892 was 4,635; of these 2,258 were joint stock companies, 2,257 were otherwise organised, while the exact business of 20 cannot be traced. Classified according to amount of capital, there were:—2,918 with less than 10,000 dollars; 1,164 with more than 10,000 dollars, and under 50,000 dollars; 227 with between 50,000 and 100,000 dollars; 286 with more than 100,000 dollars. As regards 40 commercial undertakings, the amount of their capital is not ascertainable. Among the various undertakings in Japan at the end of 1892 there were 2,767 industrial firms and factories: 493 of these employ steam-power, 247 water-power, and 247 both steam and water-power; while the remaining 1,780 are driven by manual labour only. As regards the nature of the business carried on by the 4,635 firms and companies, they are divided as follows:—429 banks or firms dealing with monetary matters; 1,415 manufactories of clothing and articles for personal wear; 333 have to do with minerals; 315 with transportation; 249 with domestic furniture; 217 with agriculture; 217 with food stuffs; 214 with articles of daily consumption; 164 with public works and architecture; 144 with marine industries; 142 with *articles de luxe*; 132 with printing; 122 with technology; 166 with sericulture; 101 with metal goods; 35 with insurance; 28 with tools and machinery; and 212 deal in miscellaneous articles.

PRIZES OF COACH MAKERS' COMPANY.

The Worshipful Company of Coach Makers and Coach-harness Makers of London offer the following prizes for competition among British subjects engaged in the trade of Coach-making and resident in the United Kingdom of Great Britain and Ireland:—

Competition No. 1.—The following prizes are offered for the two best models of an improved four-wheel close cab body, and a single or double Victoria body, with an under-carriage and wheels fitting both bodies, easily and readily interchangeable, all to be suitable for public use in the streets of London. The models must be to the scale of two inches to the foot; they are to be accompanied by a working drawing to the same scale, and may be made by one person alone, or by more working jointly. The prize models will become the property of the Company. First prize (given by Mr. G. N. Hooper), £40. Second prize (given by the Company), £10.

Competition No. 2.—The following prizes are offered for competition among members of drawing and technical classes of Great Britain and Ireland. Each competitor to send up three drawings of the side elevation of any sort of carriage. Scale one inch to the foot. The drawings are to be selected from the work of the winter session of 1895-6 by the teacher of the class. From three to fifteen drawings may be sent from a class. Prizes from £1 1s. to £3 3s. will be given for the five best sets of three drawings — total £9 9s. In connection with the above, the Company's medal may be given to the teacher of the most successful class, should the drawings to which the prize has been awarded be considered of sufficient merit.

Competition No. 3.—For working drawings of a full-sized double Brougham body, any shape, in distinct line, not shaded, scale two inches to the foot; side elevation, half back, and half plan looking on the bottom; also a cross-section at the door hinge pillars looking back. Drawings to show the framing and joints, on two or more sheets. For apprentices and others under 21 years of age. First prize, the Company's Bronze Medal and £3. Second prize, the Company's Certificate and £2.

Competition No. 4.—For working drawings, scale four inches to the foot, on one piece of paper six feet by three feet, of a Sociable with doors and hood on elliptic springs, for a pair of horses, any shape, the head down, side elevation only. All the drawings to be lightly shaded or tinted in a grey colour to make the whole clearer to the eye. First prize, the Company's Silver Medal and £6. Second prize, the Company's Bronze Medal and £4. Third prize, the Company's Certificate and £2.

Competition No. 5.—The Master of the Company (Alderman and Colonel Sir Walter Wilkin) offers the following prizes, among former prize winners only, for a fully-coloured design, in perspective, of a light State Carriage without a perch, for export, suited for the Oriental markets, to the scale of one inch to the foot. First prize, £7. Second prize, £3.

Competition No. 6.—For models of a two-wheel, low-hung Dog Cart body, with shafts and dash board, without wheels and springs, which may be varnished, but not painted; no under-carriage or steps are required. The models to be to the scale of three inches to the foot. If less than six compete, one prize of £6 will be given to the best. If twelve compete, a second prize of £4 and a third prize of £2 will be given.

Competition No. 7.—For the best written description of a four-wheel Dog Cart, any shape, giving its uses, method of construction, and material employed, accompanied by an ink drawing of the cart described to the scale of one inch to the foot. First prize, £3. Second prize, £2. Third prize, £1. Fourth prize, 10s.

Competition No. 8.—An extra prize of 10s. will be given to each prize winner if his model or drawing be accompanied by a sufficiently well-executed outline drawing (not shaded) of a bold scroll, ornament, or decoration, on paper 24 inches by 18 inches.

The prize winner in any of the above Competitions showing the greatest merit, if not already free of the Company, will have the honorary freedom conferred upon him should his drawing or model in the opinion of the judges deserve it.

All drawings and models are to be delivered free at the Hall of the Company, Noble-street, St. Martin's-le-Grand, London, on or before the 30th day of April, 1896.

THE STRAW BRAID TRADE IN CHINA.

At page 877 of the *Journal* for October 5, 1894, the prospect of increasing the straw plait trade with China was considered. The British Consul at Chefoo in a report dated in March last, thus summarises the present condition of this branch of trade, which he says continues to show an advance and is satisfactory so far as it goes, but the business is still capable of great expansion and ought to be twice as large as it is. The wheat harvest was good so that there has been plenty of straw. There was, as there has been for years past, a healthy demand for Shantung plait, and what is most satisfactory is that the plait was better made than in former years, considerable attention having been paid to the plait made of split straw, which is the most expensive form of the braid. The proposition of some European merchants to establish a straw braid exchange, the Chinese managers of which would undertake to see to the proper execution of orders and the proper supply of the market, has been laid before the Chinese authorities by the Consul. It was suggested that this establishment might be set up in the straw braid districts rather than at Chefoo itself so that the exchange might be more easily supplied, and further that each foreign merchant might more easily keep the details of his business to himself.

The matter was warmly taken up, and a definite scheme was ordered to be drawn up, but before it could be got into working order, there came first the visit of the Viceroy on his tour of inspection, and then the disastrous war with Japan, so that trade developments had to drop out of sight until quieter times. It is now stated that straw braid factories are to be established as a means of giving employment to the families of men who were killed in the war, which in itself is a most praiseworthy object. It is not impossible that the war may, for the moment, have given an impetus to the straw braid trade. The business is almost entirely in the hands of two or three rich men, who hold large stocks. Seeing a chance of the Japanese coming to loot, or of their own soldiers giving trouble, they may have thought it wise to clear out their storehouses completely and turn the braid into solid silver.

BEE CULTURE IN SERVIA.

Bee culture in Servia is at present in its infancy, but a great deal of progress has been made of late years; and at the present time, there are several bee farms of considerable size in different parts of the country. Her Majesty's Secretary of Legation at Belgrade gives in his last report an interesting account of a farm he visited at Topschidere, a village about four miles from Belgrade. This farm is the property of a Servian society called "The Society for Bee and Fruit Culture." It contains about two hundred hives, placed in regular rows over the ground, and at an equal distance of 6 feet 6 inches from each other, facing north, and in alternating rows. These hives are all on the bar frame principle, and of the pattern generally known as Dzierzon hives, and contain about eighty pounds of honey in the comb when full. They are made of wood, with straw sides, and are produced at a cost of 15 francs, or about 11s. each. This farm is under the care of a superintendent, who appears thoroughly to understand his business and the manipulation of bees. The bees appear to be a species of the common hive bee *(apis mellifica)*, but are rather small in size, and unusually tractable. The Italian bee (*apis ligustica*) does not succeed well in Servia, and on their introduction became quickly merged with those indigenous to the country. The bee farm at Topschidere is provided with two centrifugal honey extractors of very simple design, but perfectly practical. The honey is extracted from the comb in these extractors and put into glass bottles, with screw tops of a very neat pattern, imported from Austria, containing respectively ½ lb., 1 lb., and 2 lbs. The price of the honey is about 9d. per pound, exclusive of the bottle, for which an extra charge of 5d. is made. The wax is sold to the wax chandlers for making into church candles, and realises about 1s. 3d. per pound. The importance of encouraging bee culture appears to be fully realised by the members of the agricultural society, and it is said that the introduction of a law is in contemplation obliging all priests, schoolmasters, and certain other persons holding employment under Government, to turn their attention to the keeping of bees.

RUSSIAN IRON INDUSTRY.

The iron industry is one of the most important elements of the industrial progress of a country, and there are countries which have an abundance of iron-ore deposits, and yet do not devote much attention to them. This, says the United States Consul at St. Petersburg, may certainly be said of Russia. She has inexhaustible deposits of the very best iron ore, and also fuel which may be called the motive power of the iron industry, and yet in the production of pig iron, Russia is behind even France, which is not rich in iron ore. It must not, however, be assumed that Russia makes no progress in this important branch of industry. The progress made is yet but slow. During the last ten years her production of pig iron has been trebled, but it is a trifling quantity in relation to the extent of her iron deposits. In 1894, the following quantities of pig iron were produced by the respective countries named:—England, 8,251,592 tons; United States, 7,457,128 tons; Germany, 6,301,544 tons; France, 2,293,112 tons; and Russia, 1,498,648 tons. From these figures it may be seen that England produced five and one-half times as much as Russia, though England is far from being as rich in iron ore as Russia. The United States produced five times as much, and Germany four times. The United States commenced their iron industry but a comparatively short time ago, and its development should serve as an instructive example to Russia. In the Urals, where more iron ore is produced than in any other Russian region, many beds of iron deposits are not worked, and yet the Ural deposits of red hematite deserve special mention. The ore occurs in strata of the carboniferous formation, and yields as much as 64 per cent. of iron in smelting; in the same districts forests are in abundance, but are wasted by being burned down instead of being used or saved for fuel for the iron industry. The manufacture of pig iron is carried on there mainly by charcoal fuel, which is either prepared in stoves or in stacks, and chiefly from pine and birch wood, with which the country is well supplied. South Russia is also rich in mineral fuel, but so far has been very little explored as to iron ore, except on the borders of the Governments of Kherson and Ekaterinoslav, where, not far from the village of Krivoi-Rog, vast deposits of exceedingly pure and rich ores, with 60 to 68 per cent. of iron, chiefly specular iron, magnetic iron ore, and red hematite, have been discovered. The statistics showing the total yearly yield of iron ore in Russia are available, so far, only up to January 1st, 1892. In 1890, there were in the whole

of the Russian empire 536 iron-ore mines, and 195 beds which yielded 1,979,335 tons of iron ore; in 1891, there were 683 mines and 202 beds, which yielded 2,158,771 tons of iron ore. The following shows the total production of pig iron in the empire during the last five years. In 1890, 1,021,244 tons; 1891, 1,107,550 tons; 1892, 1,134,170 tons; 1893, 1,248,970 tons; and in 1894, 1,498,648 tons. The import duty on iron in Russia is of two kinds—the maximum tariff (charged on iron from the countries with which Russia has no agreement), and the conventional tariff (charged on iron from countries with which Russia has an agreement) and is as follows:—The maximum tariff on iron in bars, puddling iron, and iron rails, is 72 copecks (gold) per poud (100 copecks = 1 rouble = 3s. 2d.; poud = 36 lbs. avoirdupois). The conventional tariff is 50 copecks (gold) per poud. The maximum of tariff on sheet iron, including No. 25 of the Birmingham calibre, is 1·02 roubles per poud. The conventional tariff is 66 copecks per poud. The maximum tariff on sheet iron above No. 25, is 1·20 toubles per poud, and the conventional tariff is 80 copecks per poud. It would appear, says Consul Karel, that in Russia there are, in the direction of iron, rich fields for enterprise and industry, and a profitable opening for capital.

*AN IMPROVED PORTABLE PHOTOMETER.**

This instrument consists of a box, on the upper surface of which is a diaphragm of white card painted with a whitewash of magnesia and isinglass. It has one or more star-shaped perforations. Immediately below it, within the box, is a white screen capable of adjustment at different angles, and two small electric lamps of different candle-power, either or both of which can be used. A portable secondary battery is used to supply them with current. The illumination of the hinged screen inside the box varies approximately as the cosine of the angle of incidence of the light from the electric lamps upon it. A handle with a pointer moving over a graduated scale is connected to the screen with a system of levers, and the inclination is so adjusted that the illumination of the screen is equal to that of the perforated diaphragm, the perforations seeming to disappear when this balance is affected. The illumination can then be read off on the scale in units of the illumination due to one standard candle at one foot distance. The object of the levers is to give an open and convenient scale. The scale is graduated by expeiiment, and does not depend upon the cosine law. The colour difficulty, where arc light or daylight is to be measured, is reduced by the use of a yellow-tinted diaphragm and a blue-tinted screen, the tints being selected so that the readings are the same as the mean of a large number of measurements made with white screens. By means of a graduated quadrant and a gnomon the angle and the cosine of the angle of incidence of the light from a lamp may be measured, and rules are given for deducing the height of the lamp and the slant height, and hence the candle-power of the lamp.

* Paper read by W. H. Preece, C.B., F.R.S., and A. P. Trotter, B.A., in Section G, at the Ipswich meeting ef the British Association.

General Notes.

Soapstock from Olive Kernels.—Under the name of Soapstock a peculiar product appears to be prepared in the province of Lecce in the consular district of Brindisi. It is prepared by subjecting the residue of the olive kernels to chemical processes under the action of sulphuric acid, after all means of extraction by pressure have been exhausted. Of this substance it is stated that during 1894 the quantity produced amounted to about 1,200 tons, the medium market price for which ranged at about £18 per ton. This article, which is of little value as a lubricator, has an extensive sale for use in soap manufacture, and in years when the oil crop has been favourable, considerable quantities have been exported to America, Great Britain, and Northern Europe. This oil is locally known as "olio sulfureo," or sulphur oil, from the system of its extraction. The refuse left after the extraction of this oil is known as "Sausa," and is used for fuel for steam boilers by millers as being more economical than coal.

Royal Society of New South Wales.—In addition to the offer of prizes referred to in the *Journal* of July 20, 1894 (vol. xlii., p. 740), the Royal Society of New South Wales offers its Medal and £25 for the best communication (provided it be of sufficient merit) containing the results of original research or observation upon each of the following subjects:—Series XVI. (to be sent in not later than 1st May, 1897). No. 52.—On the Embryology and Development of the Echidna or Platypus. No. 53.—The Chemical Composition of the Products from the so-called Kerosene Shale of New South Wales. No. 54.—On the Mode of Occurrence, Chemical Composition, and Origin of Artesian Water in New South Wales. The competition is open to all without any restriction whatever, excepting that a prize will not be awarded to a Member of the Council for the time being; neither will an award be made for a mere compilation, however meritorious in its way. The communication, to be successful, must be either wholly or in part the result of original observation or research on the part of the contributor. All communications, to be addressed to the Honorary Secretaries, the Society's House, 5, Elizabeth-street, Sydney.

Journal of the Society of Arts.

No. 2,240. Vol. XLIII.

FRIDAY, OCTOBER 25, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

TECHNICAL EDUCATION COMMITTEE.

The first meeting of this Committee will be held early in December. Due notice will be given of the date appointed.

HENRY TRUEMAN WOOD,
Secretary.

FOREIGN & COLONIAL SECTION.

A meeting of the Committee of this Section was held on Wednesday, 16th inst., at 4.30 p.m. Present:—Sir Charles M. Kennedy, K.C.M.G., C.B., in the chair, Sir Owen Tudor Burne, K.C.S.I., C.I.E., Mr. Francis Cobb, Sir Westby B. Perceval, K.C.M.G., Sir Saul Samuel, K.C.M.G., C.B., Sir Charles Tupper, Bart., G.C.M.G., C.B,, with Sir Henry Trueman Wood, Secretary of the Society, and Edward Cunliffe-Owen, C.M.G., Secretary to the Committee. The programme of papers to be read during the coming Session was discussed.

Proceedings of the Society.

CANTOR LECTURES.

THE ARC LIGHT.

By Professor Silvanus P. Thompson, D.Sc., F.R.S.

Lecture I.—Delivered January 14, 1895.

PHYSICS OF THE ARC.

It is narrated of Faraday that he had a particular dislike for what he called "doubtful knowledge;" and it was one of his great achievements in electrical researches to clear up a number of things that came under that category. Some small fact had been discovered, it was obscure, it was not correlated to anything else. So long as it was not correlated to anything else, and not explained, it was unsatisfactory. And though science has gone on since Faraday's time, has developed, extended itself, become correlated all round, while now there are a hundred workers where formerly there was but one, still there are some branches of science in which knowledge is still in a very doubtful state. Into the category of doubtful knowledge I venture to put that phenomenon which was discovered by Humphry Davy during the last year of the old century, and received the name of "the arc."

Although arc lamps are to be counted by the million, though the arc light is used publicly in every town and city, though electrical engineers handle it every day, yet it still remains to be true that on the subject of the arc itself as a physical phenomenon, those of us who know most feel ourselves to be very ignorant. So much is still obscure and unknown, that—in spite of the researches of many workers—the physical nature of the arc is still a mystery. Many, however, of the complications that beset the enquiry have been gradually unravelled, and every fresh discovery brings the workers nearer to the explanation of that which is still unexplained.

To the physics of the arc, then, we devote this first lecture of the present course; the optics of the arc will claim our attention in the second; while the third lecture will deal with the recent developments in the mechanism of arc lamps.

Early Discoveries.

To introduce the subject of the physics of the arc I will begin at the beginning, and briefly recapitulate the things which were discovered in the first instance. It is sometimes said—and you will find it repeated in textbooks—that the discovery of the arc dates from about 1809. I venture, however, to put the date earlier. It was in June, 1800, that Volta wrote an account of his then newly-discovered pile to Sir Joseph Banks, the then President of the Royal Society. The pile having in that way been made public, a few workers in science immediately precipitated themselves upon that invention, and tried to find out all that could be found about voltaic piles. Amongst those who thus set work to build voltaic piles for themselves was Humphry Davy, then apprentice with Dr. Beddoes, of Bristol. In September, 1800, Davy re

counts how he was able to produce sparks that were visible in daylight from the discharge of his primitive pile; and he found in trying sparks between terminals of different materials that those sparks were of different degrees of brightness. Amongst other materials that he names, he mentions that the bright spark visible in daylight was obtained by using well-burnt charcoal. He found that to render charcoal well-conducting it must be hard, dense, well-burned, so as to be metallic in lustre, and, best of all, if it were suddenly quenched in quicksilver. This early experiment of Davy's is recounted in the October number of *Nicholson's Journal*, to which it was communicated in September. Within one year several other accounts are to be found. In the *Philosophical Magazine*, in the February number for 1801, Mr. Moyes of Edinburgh, narrates how he had produced sparks in broad daylight from a pile with some 60 or 70 elements. Then we find Davy again (having in the meantime removed to London, and become lecturer at the Royal Institution) describing, in the very first volume of the "Journal of the Royal Institution," how he also had obtained sparks of vivid brightness, using still pieces of well-burned charcoal. He describes an apparatus for taking the spark in fluids, and he continued to show this in his lectures on electricity. In that same year—1801 or 1802—Tyndall records that "Davy showed the carbon light with a battery of 150 pairs of plates in the theatre of the Royal Institution." Some six or seven years ago I was hunting up in the British Museum, for an entirely different matter, some of the early numbers of the *Journal de Paris*, and in the course of that search I came across something I had not at all expected. Under the date 22 Ventôse, An X. (March 12, 1802), I found the following entry:—

"Le citoyen Robertson, auteur de la fantasmagorie, fait dans ce moment, des expériences intéressantes, et qui doivent sans doute avancer nos connoissances sur le *galvanisme*. Il vient de monter des piles métalliques, au nombre de 2,500 plaques de zinc, et outant en cuivre rosette. Nous parlerons incessament de ses résultants, aussi que d'une experience nouvelle qu'il a faite hier avec deux charbons ardens. Le premier étant placé à la base d'une colonne de 120 élémens de zinc et argent, et le second communiquant avec le sommet de la pile; ils ont donné, au moment de leur réunion, une étincelle brillante, d'une extrême blancheur, qui a été aperçue par toute la société. Le citoyen Robertson répétera cette expérience le 25."

This same Robertson was a Frenchman of Scotch extraction, whose name comes into the outskirts of science in two or three ways. He was the man who introduced the phantasmagoria, and visited London with it a later date. It is also said that in the same year, 1802, two other persons showed the carbon light, a German of the name of Curtet, and Ritter, of Jena, the famous experimenter upon the polarisation of copper plates; but the references are so scanty that one cannot verify the fact. But it is quite certain that in those two or three years of the century it became perfectly well known that a light could be produced in that fashion between two pieces of charcoal.

I may here take two pieces of charcoal well metallised, and connecting them to the wires from a powerful source of current I will perform Davy's fundamental experiment by putting them together, and then separating them to a distance of about $\frac{1}{8}$ inch apart from one another, when at once we get this little flame of dazzling brightness between the two. The flame in this case is really very bright, both the tips of the carbons themselves shine brilliantly, and the flame itself, when using soft carbon of this kind, is very bright indeed. Holding the pencils horizontally, as Davy did, the flame is seen to take an arched form, as the result of the ascending air current. This circumstance originated the name *arc*, which we retain, though now-a-days we hold the pencils vertically one above the other, and have no arch.

If anyone doubts still that the arc light was a known thing before 1808, let him look at this book, John Cuthbertson's "Practical Electricity and Galvanism," published in 1807, wherein, on page 260, there occurs the following:—

"*Experiment* 209, *Deflagration of charcoal by galvanic action.*—The charcoal for this experiment must be made of some very close-grained wood, such as boxwood or lignum vitæ, well charred, cut into pieces about an inch long, one end being scraped to a point, and the other so that it can be held by a port-crayon fixed to the end of one of the directors; then approaching the point of charcoal to the end of the other director, light will either appear, or the charcoal will be set on fire. The particular management required should be obtained by trials. The light, when properly managed, exceeds any other artificial light ever yet produced."

Further on, at the last page of the book, the very last sentence runs as follows:—

"The quantity of electric fluid given out by the galvanic trough when compared with the quantity given out by an electric machine is worth attention.

The deflagration of charcoal (experiment 209), which has been accomplished by the galvanic trough, has never been effected by common electricity."

Now, in those early years when Davy was showing this experiment at the Royal Institution, and other people were repeating it, there does not appear to have been any very careful distinction drawn between the mere spark obtained by breaking the circuit between the points, and the continuous flame, which, as I have shown you, can be produced by putting the points together and then separating them. If I steady my hand on a stand and hold the points a little distance apart, I get a flame which persists, although the carbons no longer touch one another. If I merely put them together and separate them wide asunder, I get a momentary spark. It is not very clear from the records that the permanent flame, what we now call the arc, could be obtained; it is rather implied than described. The term "deflagration," used by Cuthbertson to describe a phenomenon which could not, as he plainly says, be produced, as momentary sparks can, by "ordinary electricity," is decisive. However, from the year 1808, there is no question whatever on that point. It was in that year that Davy drew up a kind of circular, addressed to the managers of the Royal Institution, saying that he hoped great things in the relation of electricity to chemistry to come from the voltaic pile, and begging them, if possible, to provide the means for purchasing a much larger battery. As a matter of fact, that famous battery of 2,000 cells was obtained by private subscription; and with this battery of 2,000 cells it was that Davy produced the phenomenon that created so much attention, viz., the production of a permanent flame of a great length and dazzling brightness arching over from one piece of charcoal to the other. If one substitutes for the comparatively soft charcoal that Davy first used, and that the earlier experimenters used, one of the hard carbons of the modern sort, one can manage the flame a little more conveniently. It was well known from about 1820 that the hard carbon obtained from the inside of gas retorts was a really good conductor of electricity compared with charcoal and many other things. It was in that respect comparable to the metals, and indeed, by Babbage and Herschel the hard retort carbon was actually classified amongst metals in conducting power. Hard retort carbons were introduced for the purpose of battery plates a little later by Walker, and about 1834 were used by Grove, when he wanted to employ nitric acid. He found that nitric acid would dissolve copper or iron or silver, such as had been used in some of the earlier voltaic cells, and he was compelled to employ some materials which nitric acid would not attack. He employed both platinum and retort carbon cut into slips. But his battery became known as a platinum battery, and when, in 1843, Bunsen returned to the matter, and employed carbon, many people imagined that carbon was Bunsen's invention for the purpose. At any rate, the use of hard carbon was coming in use inot the arts. Foucault, in 1843, found that hard carbon sawn in strips was a better material than charcoal for producing the arc light, and artificial carbons were being made. By this time Bunsen himself had suggested the moulding of materials for the making of battery plates. Several patents were taken out for making artificial carbons, by Greener, Staite, and Jabez Church, in England, and by Le Molt, Archereau, and several others in France. One finds, in fact, that the electrical industry was being provided with the very material required, a hard carbon of good conducting qualities. About 1844* Foucault definitely proposed the use of pencils of retort-carbon for the purpose of making the arc light. It was in 1846 that the first mechanical arc lamp was combined by William Edward Staite. Staite was one of those men whose inventions miss fire by being much before their time. He not only devised the necessary mechanism for an arc lamp, but proposed, among other things, to use two carbons parallel to one another, exactly in the same fashion that Jablochkoff did some thirty years later. Staite made a number of suggestions and improvements in detail, but does not seem to have worked much at the phenomena of the arc itself. Others, however, worked at it; Grove, the sole survivor of all the men of that time, happily still with us, not then a judge, made some experiments on the loss of weight of the carbons, to find out how much carbon was consumed by the light in a given time. He also tried other materials than carbon, and found that the addition of volatile matters, such as sodium or potassium or their salts increased the length to which the flame could be drawn out without breaking when supplied from a given battery. Daniell made some experiments, and found amongst other things that if you took your carbons and produced the arc, and let the tips get very hot, and then separated them so that the

* *Comptes Rendus*, xviii., p. 696, 1844.

light goes out, and bring them near together, they still do not light unless you bring them into actual contact for an instant. But Daniell found that they could be made to re-light by simply passing the spark from a Leyden jar discharge across—to begin the discharge, as it were. This was re-discovered by several persons later: Herschel, Van Breda, and Fusinieri all claimed to have discovered the re-kindling of the arc by means of a spark from a jar. I here repeat the experiment, using a little Wimshurst influence machine to charge a suitable jar. Even Hertz waves can kindle the arc under favourable circumstances. De la Rive experimented with the arc, and examined various other phenomena, including the beautiful rotation of the arc round an iron pole, under the influence of magnetism, which had first been observed by Walker. Foucault, in 1844, made the observation that if the current was passed to form an arc between carbon and silver, the arc was unstable; whereas, if the arrangement was reversed, so that the current flowed from silver to carbon, a long and stable arc was produced, giving out that magnificent green light which is characteristic of the spectrum of silver. He made the acute suggestion that the stability of the arc depended on the volatility of the material used as poles. He also drew attention to the action of the heat of the arc in metamorphosing retort carbon from the anthracitic into the graphitic state.

Before I go any further I may mention several additional points that were discovered in those early years. One of the first things Davy discovered was that the arc would burn under liquids. I will take these two carbon pencils and dip them into a vessel containing paraffin oil. On touching them together and separating them, I obtain a fitful, uncertain light; there is a great deal of heat produced and it gives off vapour, but as long as the oil itself remains cool, there is no fear of the vapour taking fire. The light is also toned down to a more agreeable golden tint than is the case when one takes the arc in air. If I put these carbons down into water, and in the same way make contact, I get a whiter arc, which also is still more fitful. A quantity of gas is given off, some of which is mere steam, which condenses very rapidly, some is hydrogen, some is oxygen, and there are some compounds of carbon and oxygen also given off.

Arcs between Metal Electrodes.

Returning to the arc in air, if I were to replace one of the two carbons by a bit of metal. I should get a very different effect. It is impossible to get a very steady arc between two pieces of metal, or even between a piece of carbon and a piece of metal. The kind of arc one gets depends very much on the metal one uses, and also on whether one is employing a metal as a positive or a negative electrode. Here, for instance, I am using a carbon rod for one electrode, and a bundle of iron rods for the other. There is an arc between the iron and the carbon, and the iron deflagrates off in a beautiful way in a fountain of ruddy sparks. It looks much more dangerous than it really is. If I take copper I get a very uncertain and flickering light, while the arc is of one colour if I employ the carbon as the negative pole, and another colour if I employ it as a positive pole. The copper disintegrates off more readily if it is made the positive pole than if it is made the negative pole. I am now employing solid iron; it does not deflagrate so much as the iron wire that I had before. Now I will take zinc, and I obtain this horrible roaring, hissing arc. But I may show you zinc under more favourable conditions. I will replace my metal electrodes by carbon ones, and take an ordinary stick of zinc, such as is used in battery cells. I will then make contact to it by touching it with these two carbons. If I make contact a moment with both, and then remove one of them, I shall have an arc between the carbon and the zinc. First, I will so operate that the zinc is the positive, and the carbon negative. Then I will reverse the operation, so as to have the zinc negative and the carbon positive. In one case the arc is much bluer than in the other, and it hisses much more. The arc is quieter if the carbon is positive and the zinc negative than when the zinc is positive and the carbon negative. If I employ quicksilver in the same way, I shall obtain an arc which will differ in brightness according to whether the quicksilver is positive or negative. More vapour is given off when the quicksilver itself is the negative pole. The quicksilver now is positive; that is a yellower light, and not so bright. The vapour is horribly poisonous, so we will not continue the experiment long. Professor Way, an inventor of a mercurial arc lamp thirty years ago, lost his life by the poisonous fumes.

Arcs and Sparks.

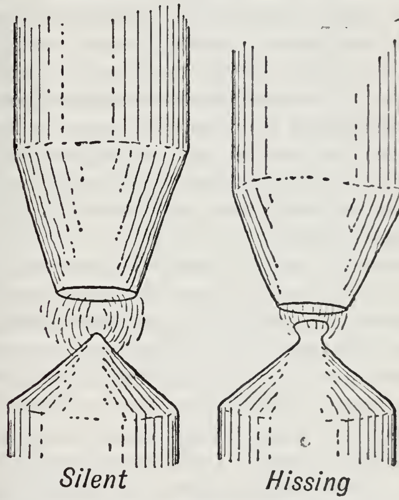
Many of the earlier experimenters are extremely vague in the way they describe the arc.

They do not give definite statements about the actual amount of the current they employed, and one can only judge of the electromotive force at their disposal by counting the number of cells, and trying to find out what sort of cells they had. Modern science gives us the opportunity of being more precise. We can say exactly what electromotive force we are using, and how much current we are actually sending through an arc. Such arcs as we have in modern practice require an electromotive force of something more than 20, and something less than 70 volts—varying generally from 40 to 50 in the case where continuous currents are employed. Under those conditions the arc produced is a very different phenomenon from that which is produced by sending a much smaller current at a much higher pressure; for then the discharge takes the form of a thin spark. If one sends a spark or a succession of sparks from an induction coil, or from a large influence machine between two brass knobs at a distance from one another in the air, the discharge that one gets resembles the arc, to some extent, but really is a very different phenomenon. The discharge one gets in vacuum-tubes, between terminals of platinum, across the highly attenuated air, is again a different phenomenon. For in neither of those two cases does the material of which the electrodes are formed play any important part in the phenomenon. In these cases, as we now know, from the recent researches of Schuster and of J. J. Thomson, there occurs an electrolysis of the gaseous medium. What you produce in these cases is a discharge carried on by gaseous particles, which move about, no doubt, and pass to and fro, and shine, but the light mainly comes from the volatile or gaseous particles, and does not come from the solid matter which constitutes the electrodes; whereas, in the true arc itself, the main light comes from the solid matter of the electrodes, and not from the gaseous matter of the flame in between. So in the production of the arc, a great deal depends—in fact, everything depends—on what that solid matter is. By universal consent, carbon is found to be the only workable material. Moreover, the carbon is consumed at one or both of the electrodes during the continuance of the arc; this circumstance alone constitutes a distinction between the two cases. Now the normal sort of arc produced between two carbon pencils is a thing that will engage our attention far more than any other arc, because it is the normal arc produced between two carbon pencils, which is of industrial value. The others are mere curiosities, so to speak; they may hereafter have an industrial interest, but at present they have only an abstract scientific interest.

The Normal Arc.

What, then, are the conditions of producing the normal arc? We have carbon pencils of the purest and best carbon one can obtain. In most cases one wants a good conducting carbon, and a fairly hard one. The pencils must be put together, and after having been put together, they must be separated to the requisite distance; then the flame springs forth. In technical language "the arc is struck." The tips become brilliantly white hot: one of them—viz., the positive one—burns away faster than the other. They assume different shapes, and the light is found to come almost entirely, by far the greater part of it, at any rate, from the white hot end of the positive carbon.

Fig. 1.



To examine the conditions of the arc, a lens is arranged so as to throw a magnified image of the arc on the screen, where we can see the shape without being blinded. You will now see in the image on the screen what justifies my statement that the light does not come from the flame in between the two. The arc is now burning steadily, and silently; the current being sent in so as to flow downwards. The top carbon, which is therefore the positive electrode is seen, Fig. 1, to have assumed a flattened form. That is the form assumed by the positive electrode, after being allowed to burn for a few minutes. There is a sort of slightly hollowed crater full of light. The current is

coming out from that crater into the flame. There is an almost invisible pale blue flame in between the carbons. The lower pencil has taken a more pointed form, a sort of peak having formed upon it, This negative peak also shines white-hot, but we do not get so much light from it as from the other, nor is its light so white in quality. If I hold the carbons at a proper distance apart you will notice that the arc burns quite quietly, and we have a silent flame. If I were to pull the top carbon up too much, and make the arc too long, it would begin to flame more and to roar, and would probably go out. On the other hand, if I make the arc too short, it would begin to hiss. Sometimes it hisses persistently when the arc is too short. You then notice another phenomenon taking place, viz., that the negative tip, which ought to be burning away while keeping of a peaked shape, acquires little lumps. There are little projections, technically known as "mushrooms," which appear upon the peak. These mushrooms always occur when the arc is hissing. When the arc is burning silently the mushroom disappears, burning away until the negative carbon comes to its proper conical shape. In the case where alternating currents are used, there is no such difference in shape between the two tips, as we shall see in due course. For the present I am considering the arc as produced when the current is of the continuous kind.

There is some difference in the circumstances attending the production of the normal arc. In America, the practice is to use two pencils of equal size, and of the same quality of solid carbon, usually coppered, and to work with arcs about $\frac{1}{10}$ inch long for a current of 10 amperes; many lamps being run in series. In England, where parallel running of lamps or groups of lamps is more common, the practice is to use as upper pencil a carbon of larger size than that employed for the lower pencil; and the upper carbon is usually "cored" (*i.e.*, made tubular and filled with a core of softer quality); while the length permitted the arc seldom exceeds $\frac{1}{16}$ to $\frac{1}{12}$ inch.

Now there is a great difference in properties between the arc that hisses and the arc that is silent. Not only have you this characteristic difference in shape, but the light is distributed differently from the surface. The quantity of current consumed, other things being equal, is different, and in fact, as I shall show presently, the conditions are completely changed. Now I would like you to contrast the effect produced in an arc burning quietly in that way with what one gets if one tries to form a current between two carbons in the same fashion at a distance from one another, using also a steady current, but employing much greater electromotive force. I have the means here, by a small continuous current transformer, of generating a small current of about 1 ampère, at a pressure of 1,000 volts. The wires from that small continuous transformer are joined up to two carbons here. This long flame is obviously quite a different thing from what one gets by using the same amount of power in the form of a larger current at a smaller pressure. It is totally different from a 10 ampère arc at 100 volts, or a 20 ampère arc at 50 volts. There is a little streak of light, but that is really more of a flame colour, and the light from the carbon tips is comparatively insignificant.

Relations between Voltage, Resistance, and Length of Arc.

As soon as electricians began to think about making arc lamps, they had to discuss how much current to provide, and at what pressure. They had to decide as to the thickness of the carbons that was required, and what length they must allow. In fact, they had all manner of things to find out, and amongst the things they did experiment upon was—What was the relation between the electromotive force, the current, the resistance, the length of the arc, and the size of the crater. They came across a very strange fact. If you consider the arc as a conductor, as a column of flame or vapour conducting the current, you will find that it does not follow the laws of ordinary conductors; when you double its length, it does not offer twice the resistance. It was a very puzzling fact, and the Swedish physicist, Edlund, who first drew attention to this fact, thought it could be explained by supposing that in the arc itself there is a sort of polarisation as there is in a secondary battery when you are charging it, or as in a voltameter when you are decomposing water.* This polarisation manifests itself as a back electromotive force opposing the current. Many researches have been made upon this matter, and I have tried to tabulate them :—

* Edlund considered that he had proved by experiment the existence of a measurable polarisation a fraction of a second after the current had been cut off. Although this persistent back electromotive force was confirmed by Latchinoff, more recent experimenters, such as Stenger and Lugger, deny its existence.

FORMULÆ SUGGESTED FOR THE ARC.

Edlund...............	$r = a + bl$
,, ...	$V = Ca + Cbl$
Ayrton and Perry*....	$V = 63 + 2{\cdot}1\ l$
Frölich..............	$V = m + nl$
S. P. Thompson	$V = m + \frac{nl}{C}$
Mrs. Ayrton†........	$V = \alpha + \beta l + \frac{\gamma + \delta l}{C}$

VALUES OF THE CONSTANTS m AND n (l BEING EXPRESSED IN MILLIMETRES).

Authority.	Date.	m.	n.
Ayrton and Perry...	1882	63	2·1
Frölich	1883	39	1·8
Penkert	1885	35	1·9
Von Lang	1885	39	..
Von Lang	1887	37	..
Cross and Shepard..	1886	37 to 39·7	1·9
Luggin	1887	40·04	1·77
Uppenborn........	1888	40·1	2·24
Duncan & Rowland	1892	40·6	1·6

The electromotive force applied to the arc to drive the current through, we may call V; it may be otherwise described as the difference of potential across the carbons. Edlund found it to consist of two parts, a part independent of the length, and another proportional to the length, l, which symbol, in these formulæ, stands for the length in millimetres. As Edlund wrote the formula, it was an expression for the apparent resistance r in terms of the length l and two constants a and b. This we may transform into an expression for the voltage V by multiplying both terms by the current C, as in the second line in the above Table of formulæ. The terms Ca and Cb are respectively the same things, as are denoted by m and n in the formula used by Frölich. They simply mean that the voltage consists of two parts, one a constant, the other varying (like a true resistance) with the length of the arc. Edlund did not himself determine the numerical value of those constants; they were not determined, as far as I know, until 1882 or 1883, and the earliest determination of that constant and the variable part is, so far as I know, due to Professors Ayrton and Perry, but I do not understand the figures in their paper, because they make out that the constant part is 63 volts, and the part which is proportional to the length is in volts 55 times the length in inches, minus a correcting term (omitted from the formula for simplicity). The diagram which they gave, which corresponds to these figures, is, to me, entirely unintelligible, unless one supposes that, in 1882, the volt-meters employed measured the voltages nearly twice too high. The other figures here given, with their dates, show a much more consistent tale: Frölich, in 1883, found the fixed part 39 volts, and the variable part to be 1·8 times the length of the arc in millimetres; Von Lang found 39 or 37 for the fixed part; Penkert found 35; Cross and Shepard 37 to 39·7; and Luggin over 40.

If we take 39 as about the average of these, we shall not be very far wrong. Now, these 39 volts that one finds as the fixed part, apparently have something to do with the properties of the carbons, for if you try arcs with any other material than carbon you get also a fixed number, but a very different one. And if you put into the carbons any other material to make them longer, for instance, soda, potash, alumina, or any metallic salt or metal, the maximum flame may be longer under different conditions, but as a matter of fact the light will be less for a given consumption of energy, and the fixed part of the voltage will also be less. Probably these low numbers of 35 and 37 are due to the presence of impurities in the carbons.

Now I should like to illustrate this matter by a diagram or two, in which some of these researches are set forth.

FIG. 2.

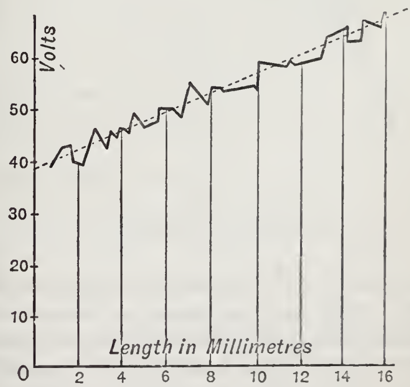


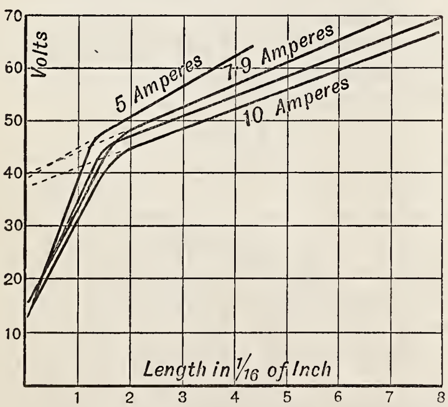
Fig. 2 is a diagram illustrating the results of Frölich's researches. The length of the arc from the crater to the peak is plotted out hori-

* Their formula had a small correcting term here omitted.
† Added since the delivery of the lecture.

zontally, the voltage is plotted vertically. In the shortest arc which could be used without hissing Frölich found about 40 volts to be the amount of the electromotive force which maintained the arc. As he lengthened the arc the voltage went up in this slightly irregular way. The irregularities may be due either to bad quality of carbon, or to the circumstance that the current was not maintained constant, or possibly to the experiments being made too rapidly to allow the arc under each of the successive conditions of length to burn long enough for the electrodes to assume the forms which they would acquire if left long enough. You will note that his curve slopes as though it intended to come down to 39, when the arc is of no length at all. To make a flame of this sort carry a current across from the positive to the negative carbon requires 39 volts, and the additional voltage indicated by the additional height to any point on the sloping line is that which is necessary to drive the current through the flame when the flame has various lengths. The longer the flame the more are the additional volts required.

Fig. 3 relates to some of the researches of Cross and Shepard. These researches are in many ways very full. For the first time statistics are given, not only for silent arcs, but for hissing ones. They made a number of determinations, trying various kinds of carbons, and also tried the effect of putting in different materials, such as soda

Fig. 3.



and potash. The experiments shown in this figure relate to one particular kind of carbon, but using currents of different strengths; one set when using a current of 5 amperes, another when using 7·9 amperes, another 10 amperes; and they found that if they pursued the thing down, beginning with a long arc, and gradually shortening it, and adjusting the current to the same amount as before, that the voltage fell, in all cases, as though it intended to go down to 39 volts, when the length is reduced to an appreciable amount. But as soon as the arc begins to hiss, then the curve changes; there is much less electromotive force required to maintain the hissing arc than the silent arc, and the hissing arc appears to point somewhere to 15, 14, or 13. The hissing arc is very unsteady, however, and the exact form of the curve is uncertain here. To maintain a hissing arc wants very much less electromotive force than to maintain a silent arc of no appreciable length; but in each case there is a part of the voltage fixed, and a variable part depending upon the length of the arc. I might give you, in similar curves, the results of nearly all these experimenters; but I should be only giving you the same thing over and over again.

I have found that, by gently blowing sideways on the arc, so as to cause it to take a longer curved path, its resistance is increased: it then requires a higher voltage to maintain the current. The arc is indeed curiously sensitive to winds and draughts. It can quite easily be blown out like the flame of a candle.

Physical Nature of the Arc.

I ventured in a lecture I gave here in the year 1889, on the mechanism of the arc lamp, to make some remarks about this phenomenon. I began, however, from the optical point of view, from the researches of Captain Abney, which will engage our attention next week. Captain Abney had found the white surface of the luminous crater to be always of an equal degree of whiteness, which obviously means that it is always of an equal degree of temperature. No matter whether the current going through the arc is small or large, using big carbons or little ones, or whether the arc is long or short, the whiteness of the crater surface is always alike, and, therefore, of the same temperature. With large currents the area of the crater surface is large; with small currents it is small; its quantity but not its quality changes when the current is altered.

I suggested at that date that the true explanation of this constancy in the intrinsic luminosity of the crater surface was that its temperature was fixed by physical conditions. It appeared that whether the current was large or small, the temperature at that surface could not rise, and could not fall; that it was, in fact, as fixed as the temperature at which ice melts or water freezes. The only thing that

could account for there being a fixed temperature for the crater surface was the fact that the carbon is at that surface in a state of volatilisation; that the carbon is evaporating off from the positive carbon into the arc or flame.* At that surface you necessarily must have the temperature at which carbon evaporates, just as you cannot have the surface of ice under ordinary conditions either hotter or colder than the temperature which is taken as zero of the Centigrade scale. If you take a piece of ice and put it in front of the fire, the ice itself does not get any warmer; it simply melts off at the surface, the surface of the solid remaining equally cold, as before. So the surface of a piece of carbon, when in contact with its own vapour, must necessarily be at that fixed temperature. That seems to be now the generally accepted idea.† I want now, however, to go a little further, and to suggest another idea to you.

It was found by Despretz, about 1850, that carbon, just before it volatilises, becomes very soft; in fact, he obtained good evidence of plasticity in carbons when heated up to very near the temperature of the arc. Now that means, of course, that there is, at any rate, an incipient liquefaction going on a few degrees below the temperature of the volatilisation. Now the temperature of liquefaction will also be a fixed temperature. If you have a film of literally liquid carbon lying on the top of solid carbon there must be a fixed temperature where they come together at the surface where the carbon is melting. There is some evidence that such films exist over the crater surface; but the temperature of the visible surface of the crater is the temperature at which solid carbon volatilises. My present view of the physical state of the arc crater is that the solid carbon below is covered with a layer or film of liquid carbon, just boiling or evaporating off.

The Hissing Arc.

When hissing takes place, a new state of things is set up. If you watch a short hissing arc you will see a column of light concentrating itself on a narrow spot, and that spot keeps moving about, and is very unstable in position as well as in the amount of light it gives out. The contracted spot from which the light seems to start pits deeper into the carbon. I think the first mention of this pitting effect of the hissing arc is not recorded anywhere yet, unless it was mentioned by Prof. Ayrton in 1893 in the paper he read at Chicago, which has never been published. I myself derived the information from Mrs. Ayrton, who made the observation that the crater surface, after the arc has been hissing, is found to be literally honeycombed. When the arc is hissing, you can see little bits erupted out, and the hissing seems to be comparable to the hissing which takes place in water just when it is beginning to boil. If you have some water being heated in such a way that there is not more than a certain quantity of heat given off from the surface, you have the water evaporating quietly, but you cannot get more than a certain quantity of heat given off per square inch of top surface of the water in that quiet way. If you force more than a certain quantity of heat to pass off per top square inch of the water, you find the water begins to break up internally, and you have bubbles formed below the surface, the surface breaks up, the bubbles are thrown out, and you have a noisy phenomenon. I think you will find there is exactly the same kind of difference between the silent arc and the hissing arc as between quiet evaporation and noisy boiling. There is a sort of decrepitation, as though solid particles were being torn asunder to make way for something coming out, when the arc is hissing.*

Location of the Back Electromotive Force.

Another point which remained doubtful for a long time, even after Edlund had made his observations, and these measurements had been made, was whether this fixed voltage that appears in the arc was really the back electromotive force, as Edlund supposed, or whether it was a "transitional" resistance—a sort of resistance located at the surface of transition which, instead of being a constant, as resistances usually are, varied inversely as the current. That was, indeed, Schwendler's view. Schwendler said here is a resistance which varies inversely as the current; when you double the current, the resistance goes down one-half, therefore you want exactly the

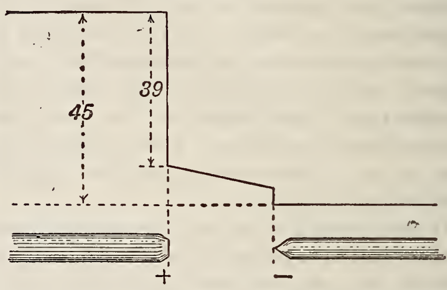
* See an excellent lecture on the "Arc Light," by Prof. Elihu Thomson, in *Electrical World*, xvii., p. 166, Feb. 28, 1891.

† Some recent experiments by Mr. W. E. Wilson (see "Proc. Roy. Soc.," May, 1895) are supposed to throw some doubt upon my theory; they are referred to below.—S.P.T.

* For other observations on the "hissing" phenomenon see—Cross and Shepard, "Proc. American Acad.," 1886, p. 227. Niaudet, *La Lumière Electrique*, iii, p. 287. Luggin, *Electrician*, xxvi., p. 565. Spencer, *Electrical Review*, xxxiii., p. 496. Andrews, *Journal Soc. Teleg. Engineers*, ix., p. 201. Cravath, *Electrical World*, xix., p. 195.

same voltage as before to drive that double current through. After all, it may be only a *facon de parler* to call this by either name, but, at any rate, reasons can be adduced in favour even of so improbable a view. Suppose there is a surface between a solid on one side and a vapour on the other. Apart from any question of evaporation going, or matter being given off from the solid into vapour at that surface, there is at that surface a difficulty in the current getting out from the material in one state to the other ; that resistance will be, other things being equal, inversely proportional to the surface. 1 sq. mm. of surface will offer a certain amount of difficulty ; with two square mm. you will have two possible paths, and the difficulty of transition will be halved. If there is anything that goes by area, then if the resistance is transitional, as it is supposed to be, it will vary inversely as that area. Is there anything that goes by the area? Yes ; the size of the arc which determines the size of the crater—I mean the cross-section of the arc is found to be almost exactly proportional to the current. If by any possibility you alter your current and pass twice as much current as before, I do not say it will burn equally steadily, but you will find the crater's area will be almost double. This observation was made a long time ago by Mr. J. D. F. Andrews, and is recorded in the "Journal of the Society of Telegraph Engineers." If then the current produces a crater proportional to itself, and the transitional resistance varies inversely with the crater surface, it will vary inversely with the current, and the effect will become the same as though there were a fixed electromotive force. But I do not think that is the true explanation, because I do not believe in this transitional resistance. It seems to be a way of explaining a thing by introducing something which is much less understandable. When you have come to this explanation you have to explain the transitional resistance ; but you can explain and see the reason for a counter electromotive force. Whenever work is done by a current in a circuit, it is always done by virtue of a back electromotive force. The fact that there is a back electromotive force in a motor enables you to utilise the electrical energy. The fact that there is a counter-electromotive force in an accumulator that you are charging, enables you to store chemical energy in it. The fact that there is a back electromotive force in an arc enables you to do work in that arc. If there is a back electromotive force, it ought to have a definite seat. Has it a definite seat? Where are these 39 volts? Are they at the crater surface ; are they distributed all along the arc ; are they at the negative peak? That was one of the points which was entirely uncertain until a few years ago. Several of us have worked at it, Prof. Fleming, and Prof. Ayrton, amongst others. An observation which I made some years ago, was communicated to the Electrical Engineers at the time. I made an arc in the usual vertical way, with the positive carbon at the top. In Fig. 4, in order to plot

FIG. 4.



volts vertically against lengths horizontally, the arc is represented as turned over on its side ; and the distance between positive and negative electrodes is greatly exaggerated. Into the space between the crater and the peak I then introduced a third carbon to act as an explorer. The difference of potential between the two points, as measured with a voltmeter, was about 45 volts ; and to measure this the wires of the voltmeter must be connected, the one to the negative, the other to the positive carbon. But if one wire is connected to the negative carbon, and the other to the third or exploring carbon, one is enabled to go fishing about to find how this 45 volts of potential difference is distributed along the arc. If the arc merely operated as a plain resistance, the fall of potential would be found to be distributed along the length equably ; when the exploring carbon had been moved through half the length the voltmeter would just show $22\frac{1}{2}$ volts. But nothing of the sort is found. At a point half-way along the potential was found to be about four volts higher than the negative carbon ; and as the third carbon was moved towards the crater, this rose to nearly six volts. This process, then, enables one to locate the whereabouts of these 39 volts of back electromotive force. Suppose one plots out vertically the results of the observation (as in Fig. 4), the high-level line to represent the potential of the positive carbon, the

low level line the] potential of the negative carbon; then the volts drop from high to low, somewhere or other in the distance from crater to peak. We might, of course, have measured the voltage drop from the positive carbon downwards, instead of measuring it from the negative carbon upwards. This method of exploration is precisely similar to that known and used for years in examining the polarisation of secondary batteries. Inspection of the diagram that has been plotted from the observations shows that there is a a drop of something like 39 volts at the crater, and then there is a slight regular drop all the way down the arc, due to the fact that there is current going through resistance; then there is a slight drop at the other end of the peak. I measured that slight drop to be two or three volts; but in one case, where the arc was hissing, I found at that place a slight rise. Other observers*, have also obtained a rise at this end showing that some inverse phenomenon is going on there. The same kind of thing occurs frequently in electrolytic observations. One finds the potential of the intermediate liquid lower than that of either of the materials at the two ends.

If there were a hissing arc instead of a silent one, the drop at the crater would be found to be only about 13 volts there, and the whole voltage from one side to the other would be very much less. Many years ago the observations was made by M. Niaudet that the current, if supplied under certain conditions, increases at the moment when the arc begins to hiss; if supplied under certain other conditions it, however, decreases at the moment when the arc begins to hiss. This apparent back electromotive force has not only been a puzzle to the investigator, but it has led to several fallacious suggestions. There is a remarkable paper in the *Comptes Rendus* for 1884, by the late Prof. Jamin. Jamin was an intelligent man, but he formed this extraordinary opinion that an alternating current arc would necessarily be much more efficient than any arc could possibly be when produced by a continuous current, whether from a battery, an accumulator, or anything else. For, said he, if you work with a battery or an accumulator, that current always flows in one direction, and you have 39 volts against you, that means a pure loss of energy, which is thrown away; whereas if you work with a rapidly alternating current, the back electromotive force will help you at each reversal of the current. Therefore, the alternating current will be very much more efficient. Of course, the whole thing is a mare's nest. Jamin did not understand that the essence of getting work out of a current, whether from a motor or an arc, was to have back electromotive force.

Another matter which has never yet been properly cleared up is the transport of matter across from one side of the arc to the other. Unquestionably in a hissing arc there is a large transport; particles of carbon in solid or liquid state being visibly projected across the gap to form the mushroom on the negative peak. Besides this bodily transport, there is probably also a molecular transport by evaporation at one side, and condensation at the other. But the hissing arc is not the normal phenomenon, and the transport of actual particles is abnormal. In a silent arc there is very little. You may, in fact, substitute as a negative pole a piece of metal, if you keep it cool and prevent it from melting. The evaporation of carbon at the positive surface is quite sufficient to keep the arc going. However, some researches have been made on this point. Sir William Grove thought he got a transport in both directions, as did Matteucci, who employed, instead of carbon, a pole of iron and a pole of copper. On examining the two surfaces after an arc had been allowed to play across, he found that some carbon had been carried over to the iron, and some iron had been carried on to the surface of the copper. But the spluttering effects one gets when using metals in this way make one very unwilling to accept such results as conclusive. A recent experiment of M. Blondel in photographing the image of the arc proves, if anything can prove, that there is only one direction in which material is ever transported, and that is from the positive side to the negative—from the crater to the peak.

Alternate-current Arcs.

I have the means here of showing an alternating current arc. We will turn on the current from the London Electric Supply Company, and I will show the alternating arc first by means of one of those nearly obsolete devices, one which has now become almost a museum curiosity, a Jablochkoff candle. All honour to Paul Jablochkoff. In the year 1877, he revived this elementary method of providing for an arc; avoiding all mechanism, by simply putting the two carbon pencils

* Dr. Sahulka *Zeitschrift für Elektrotech.*, Nov. 1894; but see J. A. Fleming, "Electric Lamps and Electric Lighting," (Electrician Series) p. 155.

parallel at a suitable distance apart, one by the side of the other, with a bit of plaster between. On switching the candle into circuit the alternating current passes from one point to the other after being started by a temporary bridge-piece. Jablochkoff used the alternating current, simply because it was essential that the consumption should be equal at both tips. In the use of the alternate current the actions at the tips reverse at every reversal of the current. For an instant the current flows in one direction, then reverses, only to reverse back again. For a brief time the crater will be forming on one tip, and the negative peak on the other; then a very small fraction of a second afterwards the action is reversed, and so the two carbons are consumed away at equal rates. But, for my own part, I do not admire the light from the Jablochkoff candle. It always roars and hums because of the alternations that are going on. The light is down in a hole between two carbons, so that it is not diffused in the most satisfactory or economical or agreeable way.

High-voltage Alternating Arc.

While I have an alternating current here I should like to show you another arc phenomenon that is not often seen, at any rate, outside electric lighting stations. I refer to the alternating current arc at 2,000 volts. The arc that one gets from a current when elevated to such a high electromotive force as that will be very much more like that which Davy produced with his charcoal points and his battery of 2,000 cells. That is to say, it will be a real arch of flame between two points, and this arch will be blown upwards by the ascending current of air. You will notice that the whole arch itself is more or less luminous. You see that we get great roaring flames, but you will be astonished to find how little carbon is consumed by this 2,000 volt arc. In fact, the higher one goes in voltage with the arc the less carbon is consumed, and, in some cases, the less light you get. But the consumed carbon is very small, and these flames appear to be rather of the nature of true flames. Only there is this difference: instead of taking combustible materials, putting them together and burning them in order to get out heat, you are taking materials which do not ordinarily burn together, viz., the two constituents of the air, nitrogen and oxygen, and you are forcing them to burn together by pumping heat into them. It is an endothermic flame, instead of the ordinary exothermic flame. It is a flame which takes in heat from the current, which requires to be fed with heat, in order to exist at all. Certainly some of the luminous phenomena one gets with high voltage, and at high frequency, are of this nature, and, therefore, are not like the true arc. In the arc itself, when made in the air, undoubtedly there is a combustion of the air, that is to say, the oxygen and nitrogen of the surrounding air are burnt together by the heat, and also both of them combine with carbon.

Chemistry of the Arc.

The chemistry of the arc has never been thoroughly worked out. Professor Dewar, amongst others, has worked at it, and shown that not only do you have carbonic acid and carbonic oxide produced, but nitrogen compounds, prussic acid, cyanogen, nitrous acid, and various others. He drew off the gases through tubular carbons and analysed them.

I do not think any one has in any record called attention to the *smell* of the arc lamp. The arc certainly has a very characteristic odour, probably due to the fact that the carbon is combining both with nitrogen and with oxygen, and that the nitrogen and the oxygen are combining together, giving rise to compounds which, though more or less poisonous, are happily produced in very small quantities, and give a decided odour to the air where an arc is being made. These flaming arcs, at high voltages, very soon produce a perceptible odour; whereas a normal arc, produced actually by 40 to 50 volts, gives very little smell indeed, and sets free extremely little of the disagreeable nitrogenous products.

Magnetic Properties of the Arc.

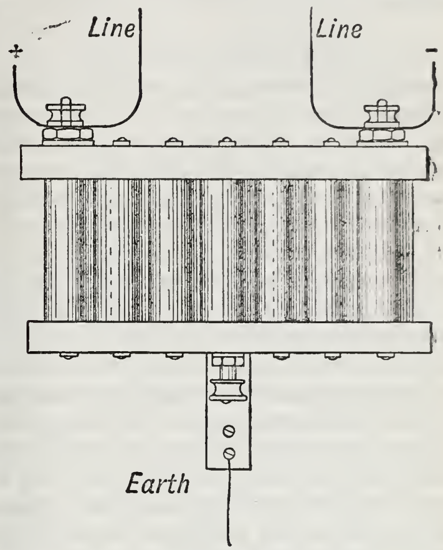
Amongst the early things that Davy discovered was the effect of a magnet on the arc. He showed that the arc behaved like a flexible conductor, and a magnet being put near it caused it to bend to one side or the other. If the current in it is ascending, it is bent to one side in the magnetic field; and if it is descending, the arc is bent to the other side. In the case of the horizontal arc, it makes a difference whether the current is flowing eastwards or westwards: in the one case, the earth's magnetic field tends to bend it up, and in the other case it tends to bend it down. As a consequence, you can get a larger maximum length of arc with a given current, if the current comes in at the east and goes out at the west, than if it comes in at the west and goes out at

the east. Also, with an alternating current arc, where the current flows alternately up and down, the flame of the arc is literally pushed on one side. If you examine an alternating-current arc in a mirror that rotates round a horizontal axis so as to get a succession of images thrown out vertically, you will find that that those images are successively curved right and left, owing to the effect of the earth's magnetism. Walker and De la Rive observed the arc to rotate round a magnetic pole; and a number of kindred experiments have been made which are very curious. I will only show you one. Here is an electromagnet which I can introduce into the circuit. I will take a pair of carbon pencils, and placing them between the poles of the magnet, I will try to obtain the arc, using 40 or 50 volts in the arc circuit. You know that ordinarily the arc goes out if the carbons are parted too far. When it does go out it does not make much noise; there is a slight sound like that heard when a candle is puffed out. But try it between the poles of that magnet, what do you find? You cannot even get the arc to keep alight. It flops out instantaneously with a sound almost like a pistol shot. The flame is blown inwards or outwards, according to whether the current is flowing down or coming up. You notice that I put one carbon at the top, and the other at the bottom, and then the magnet blows the flame outwards. If I reverse the carbons and put the negative at the top, the flame will be blown inwards. Even if one works at some distance away from the poles of the magnet, you still observe this very peculiar effect. To burn the arc steadily in a strong magnetic field is almost impossible. If I had a larger electromotive force, say 300 or 400 volts, so that I could support a long flaming arch between those two carbons, and were to form such an arc, it would be blown out sideways, like a blow-pipe flame. This was observed long ago by Quet in 1852, and in 1874 by the late Mr. Werdermann, who proposed to employ it as a sort of blow-pipe. He set two carbons side by side like a Jablochkoff candle, and arranged a magnet to blow out the flame in a long tongue, for use in soldering or lead-burning, instead of a blow-pipe. Recently others have combined magnets with arcs for the purpose of making electric blow-pipes. The Benardos process of electric welding and forging is based on this particular use of the arc.

NON-ARCING METALS.

It has often been noticed that certain metals will hardly arc at all in a continuous way. If you take two solid cylinders of zinc, or two cylinders of antimony, and put them close together, and connect them on to the electric light mains, and then start an arc, by sparking across, the arc will not maintain itself. It splutters itself out instantly. This property has been made use of in America, where atmospheric disturbances are much more serious than in this country, for the purpose of constructing a non-arcing lightning arrester. Fig. 5 is a rough sketch of one

FIG. 5.



form of this device. The inventor, Mr. A. J. Wurtz, made an exhaustive research* to ascertain which of the metals do, and which do not arc. He found that nearly all metals will arc, excepting zinc, antimony, and bismuth. Take the case of an electric station, working on an arc lighting system, supplying 40 or 50 lights in series. There is employed a potential of 2,000 or 3,000 volts. If a lightning flash were to start an arc from the outgoing line to the incoming line, it would set up a most destructive arc. In order to prevent any such catastrophe happening, there must be provided a lightning arrester. But the lightning arrester might go on carrying the arc if it were not made of non-arcing material. This is Wurtz's invention:—A cylinder, made of a particular sort of brass, with a high percentage of zinc in it, is connected to one line, while another cylinder is connected to the other line. Between them—nearly touching one another—is a row of intermediate cylinders.

* See *Electrical World*, vol. xix., 1892, pp. 234 and 245.

The middle cylinder in the row is put to earth. Those on each side are not connected with anything at all, but merely fixed in a frame of stoneware, or some non-conducting material. Then, if either of those lines is struck by lightning, there will be a momentary spark across those cylinders in series; and the discharge will go down to the earth, instead of going to the power-house and deranging the machinery, but it will not persist as a continuous arc; the discharge will splutter itself out instantly. It is not precisely known why this effect occurs with the metals and alloys named and not with others.

Temperature of the Arc.

Until quite recently, the most wild guesses were all that could be learnt about the temperature of the arc, or of its various parts; such numbers as 10,000° C. and 500,000° F. were quite common. Becquerel, in 1860, suggested 2,070° to 2,100° C. as the probable temperature of the arc between carbons, his source of current being a battery of 80 Bunsen cells. In 1879 Rossetti published a research, based on observations of the radiation, in which he came, not without some doubts, to the conclusion that the respective temperatures might be stated somewhat in the following terms:—The temperature of the positive crater somewhere about 3,900°C., that of the negative peak about 3,150° C. He concluded that the arc itself, although it gave, being gaseous, less light, was actually hotter, and he suggested 4,000° C. as being the best guess available. Rossetti's value of 3,900° C. for the temperature of the crater has been re-examined quite recently, in America by Nickolls, and in France by Violle. By two independent methods of measurement Violle arrived at numbers a little less, his final number at present being 3,500° C. He has arrived at this most recent measurement in a curiously direct way, viz., by a calorimetrical measurement. He arranged an arc in the following manner. The positive carbon was provided with a small end piece which at any moment could be knocked off and dropped into a calorimeter. This end piece was made the crater of the arc, and was allowed to burn away until it was quite thin; the supposition then being that it would nearly all be at the same temperature as its luminous surface. Then it was dropped off into the calorimeter, and the amount of heat it gave out in cooling was measured. The rather extravagant assumption had to be made, that the specific heat of carbon at this high temperature might be found by extrapolation from its known specific heat at lower temperatures; and the number arrived at agreed with the number derived from the observation of radiation. Mr. P. H. Gray has independently arrived at the value 3,400°. So we may attribute a fairly reasonable accuracy to Violle's number, 3,500°. We know that the lower carbon, the negative, is a good deal cooler. Violle's number for the negative carbon is about 2,700° C. He has recently brought forward evidence to show that the arc itself is probably hotter than either the positive or the negative carbon tip. That was previously a matter of inference from the nature of the radiations; spectro-photometrical observations being the basis. The new evidence is this: make the arc using, not carbon, but a material which forms an arc at a lower temperature, zinc being the material in question. The temperature of the crater will, of course, correspond with the temperature of volatilisation of the zinc. Now, if into the flame between the positive and negative zinc tips you use some material which is less volatile or less fusible than zinc, you can again, by the aid of the spectroscope, satisfy yourself whether it is hotter or not. Violle found that the arc between the zinc poles could raise a piece of carbon to a temperature distinctly higher than that of either the positive or negative sides; consequently, by inference, the flame in the carbon arc is hotter than either of the two tips. It is to be hoped that other physicists will work at this question. There is really a great deal to be done on that part of the physics of the arc. Still more recently Violle has returned to the question whether the intrinsic brightness of the crater is independent of the strength of the current. His latest announcement is that when he took a very large piece of carbon, and made arcs with as small a current as 10 ampères, and as large a current as 1,000, the intrinsic brightness of the crater surface, that is to say, the amount of light emitted per square millimetre of surface, was the same.

Effect of Conductivity of Carbon Pencils.

If the pencils of carbon used are of insufficient cross-section, or of a badly-conducting material, they will heat throughout their whole length, and waste an undue proportion of heat by offering a useless resistance to the current. From the point of view of economy a good-conducting quality of carbon is to be preferred. But, apart from the question of economy,

the matter is of importance. If a pencil of insufficient section, in proportion to the current it must carry, is used as the positive carbon, the crater cannot be properly formed, and the arc will be more or less unstable, while the flame will lick around the rim. On the other hand, if the pencil is too thick relatively to the current, the crater will be very deep, and again the arc will burn unsteadily, as the crater shifts its place from moment to moment. For a 10-ampère lamp one frequently finds the positive pencil to be an uncored carbon 9 or 10 mm. in diameter. If a carbon with a soft core is used, a slightly larger size is admissible. It is usual to employ for the lower negative pencil a carbon not cored, 1 or 2 mm. less in diameter than the upper positive carbon.

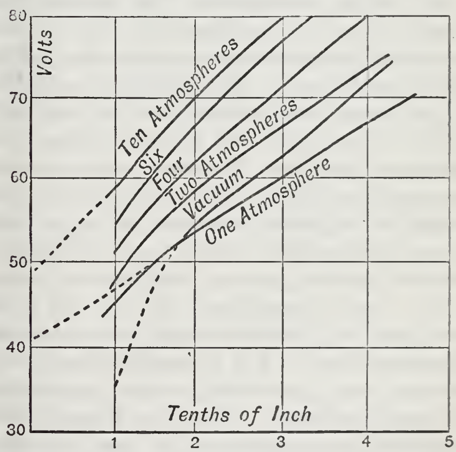
If the carbon is of such poor conductivity, or so thin, relatively to the current it has to carry, as to become red hot for more than a few millimetres beyond the luminous tip, it will waste by oxidation in the air, and become coned for a considerable length. A pair of such carbons are depicted in Fig. 6, at A. It was long ago suggested that the conductivity of carbons might be improved by plating them with a film of conducting metal. At B and C, in Fig. 6, are shown the forms assumed by carbons of the same quality, when they have been coppered or nickelled. The current flows freely down the external metal skin without materially heating the pencils along their length. In the immediate neighbourhood of the arc the metal is volatilised and disappears. Coppering is now seldom resorted to, as the carbon pencils of modern manufacture are of higher conductivity, and do not require to be coated. The conductivity of good moulded carbon pencils, such as are now used, is from 15 to 20 times as great as that of pencils sawn out of gas-retort carbon, being only from $\frac{1}{10}$ to $\frac{1}{5}$ ohm per foot of length. But coppering would reduce these values ten or twenty-fold.

Fig. 6.

Effect of Surrounding Gases on the Arc.

Another matter that has received extremely little attention is the effect on the arc of the surrounding medium. Until recently, it was not known what would be the effect of increasing the pressure of the air, or of surrounding the arc by different materials instead of atmospheric air. At a time before this 39 volts of back electromotive force was as well recognised as it is now, it was supposed that this constant part of the voltage had something to do with the surrounding air; that in fact it was due to the oxygen and carbon combining. In order to disprove this notion, I had some experiments made* three or four years ago, with arcs burning in different materials, in chlorine, in coal-gas, in hydrogen, in nitrogen, &c. I found that it did not make one volt difference what the surrounding gas was. The 39 volts were still required as the minimum electromotive force for a steady arc. Incidentally I observed that the shape of the positive crater and of the negative peak is quite different, and differs in different gases. In coal-gas one finds that the hydrocarbon becomes deposited in the form of a mantle all around the crater, so that the negative peak penetrates up into a sort of chimney of deposited carbon. When one works at reduced pressures one begins to get into the vacuum-tube order of phenomena. The arc may be drawn out to a great length, and expands in size; but the luminosity of the tips of the carbons diminishes, and the phenomenon of the crater changes. Very little carbon is volatilised, and the electromotive force required to sustain the discharge is lessened.

Fig. 7.

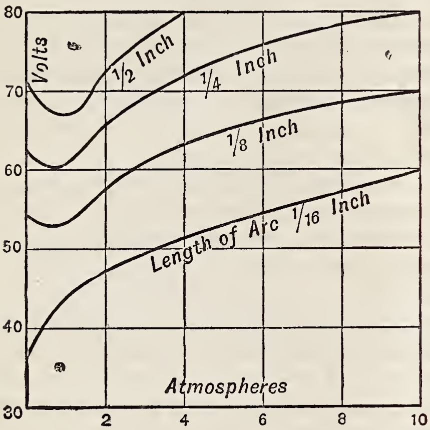


When, however, one increases the pressure, one meets with arc phenomena that are slightly different from those at atmospheric pressure. Here we have the justification of the view that

* See *Electrician*, xxix., p. 460.

the 39 volts is due to the work done in the vaporising of the carbon. So far as I know, much the most complete experiments yet made on this point are those made in America by Dr. Louis Duncan* and some of his students. Figs. 7 and 8 embody in diagramatic form the principal results of the researches.

Fig. 8.



Duncan caused the arc to be made in a vessel into which the air could be pumped, or from which it could be exhausted. Take first the case of the arc made at the ordinary pressure of one atmosphere. The sloping line marked "one atmosphere" in Fig. 7, here shows the connection between the volts and the length of the arc; the lengths in successive experiments being plotted out horizontally in $\frac{1}{10}$ths of an inch. We have in general the same sort of sloping things as previous experimenters have found. But the lines that correspond to different pressures all slope down from right to left. They are not all straight, though straight over a considerable range. The "one atmosphere" line is not quite straight, for it begins to turn down when the length is small. But its straight part points toward 40 or 39 according to the current that is being employed. Now if my theory is true, that the arc temperature is that at which carbon is vaporised, it follows that if you put on the pressure you ought to have exactly the same sort of effect as happens in boiling liquid when you put on pressure; you raise the temperature of boiling. In the present case you raise the temperature of evaporation, and require more energy to make it boil; that is to say, it will boil, other things being equal, with a bigger back electromotive force. The diagram shows the line for 2 atmospheres, for 4, for 6, and for 10. Let us pass at once to the last as being the extreme case. The "ten atmospheres" curve points back to 48 volts instead of 39, proving, in fact, that more work is done by the current in going through the arc when it is made more difficult for the carbon to evaporate from the crater into the arc itself. There are some other things which might be noticed in this figure. For instance, when working in a vacuum, short arcs require less electromotive force, and long arcs a greater than is required in air at the orninary pressure. The next diagram, Fig. 8, is also one of Duncan's, plotted out in a different way. Here he is employing a constant length of arc, but varying the pressure. As you increase the pressure from vacuum first to 1 atmosphere, then to 2 atmospheres, and so on, you notice what happens. With a very short arc there is a continuous increase in the volts required, but if the arc is $\frac{1}{8}$ inch long, and you pass from vacuum to 1 atmosphere, you want fewer volts. It is easier to send an arc through air than through vacuum when it is only $\frac{1}{8}$ inch long, but after that the electric pressure required increases. Suppose you begin with a $\frac{1}{2}$ inch arc, there is a very distinct lowering of the voltage, but a little over 5 per cent. in amount. Yet, on raising the pressure above 1 atmosphere, the voltage again increases. All this points to something not yet discovered.

Now, let us try to sum up what is known on this point. Carbon, the most refractory of known substances has a definite temperature of volatilisation when the pressure is kept constant. Change of pressure will change that temperature. However intense the heating effect of the current, however fiercely we pour in energy by means of the electric circuit, we cannot raise the free surface where the carbon is evaporating above that limiting temperature. Increasing the rate at which heat is poured in will simply increase the rate of evaporation. Further carbon is found at these elevated temperatures to have chemical properties of the most active kind. No known compound exists that is not dissociated at arc temperatures. Put any of the most refractory substances known—lime, magnesia, alumina, asbestos—into the arc, they are dissipated, reduced, volatilised; mix any of them with the carbon, and one finds that, *without exception*, the effect of their presence is to reduce the temperature, to lower the degree of luminosity, and—what is most significant—to lower the

* L. Duncan, A. J. Rowland, and C. Todd. See *Electrician*, xxxi., p. 360.

apparent back electromotive force. Increase of pressure, however, raises the temperature and raises the luminosity. What a glimpse this gives us of the possible state of things going on at the surface of the sun. For some reason—into which I need not enter—the temperature at the sun's surface is very high, higher, to judge by the radiation, than that of the crater of the arc. Also, the pressure of the solar atmosphere, at the level of the sun's surface, must be much higher than the one atmosphere of our air. At such temperatures (and pressures) all known chemical compounds would be dissociated into their elements, and all the known elements would be volatilised. The last element to be volatilised would be carbon. Are we not justified, then, in hazarding the suggestion that the luminous surface of the sun, to which it owes its brightness, is in reality a surface of incandescent carbon? If not, what else can it be?

[*Remarks since added, Oct.*, 1895.—It is only just to add, in view of later researches, that there is some evidence not concordant with the views put forth in this lecture in January. Experiments made in Ireland by Mr. W. E. Wilson* go to show that under certain conditions the light given out by an arc lamp is reduced in brilliancy when the lamp is burned under a pressure of several atmospheres. Mr. Wilson considers that he has shown that the intrinsic luminosity is lowered. If this should be established, it will of course mean that the temperature also is lowered by pressure, and that, therefore, the temperature of the arc cannot be considered as dependent upon the temperature of volatilisation of carbon. But it remains to be proved whether the temperature of volatilisation of carbon is so lowered by pressure. The matter is complicated by the circumstance alluded to in the lecture, that the melting point of carbon is so close to its boiling point. In the absence of any knowledge as to whether at the fusion point any change of volume occurs, and whether such change be an expansion or a contraction, it is impossible to say whether increase of temperature will raise or lower the melting point. All one can say is that the question raised is still in suspense, and that for the present Mr. Wilson's observations are distinctly against the theory put forward.

Further, in September, 1895, at the meeting of the British Association, Professor Ayrton and Mr. Mather communicated a paper on the apparent back electromotive force of the arc, which they had been examining by a new method of electrical measurement. This method cannot be discussed here, but there are grave doubts as to its validity. Using this method the extraordinary result was obtained that the supposed back electromotive force is a negative quantity, that is to say, instead of an electromotive force opposing the current, they found a forward electromotive force helping it. If this were true it would involve the admission that the arc would be acting as a source of electric power, and it would also involve the admission that the resistance of the column of vapour of the arc is greater than can be accounted for by the fall of potential per unit of length, both of which conclusions would be inadmissible.—S.P.T.]

* "Proc. Roy. Soc." May 30, 1895, or see *The Electrician*, June 21, 1895, p. 261.

Researches of Prof. Ayrton.

Any account of the physics of the arc would be incomplete which did not include a reference to the researches of Professor Ayrton. I listened, when at the Electrical Congress at Chicago in 1893, with the utmost delight to a very elaborate paper, which cleared up a number of doubtful points, and gave us far more complete details about the phenomena of the arc than anything hitherto available. The same sort of observations had been made by Professor Ayrton, and by Mrs. Ayrton, as those which I and other observers had made in time past. They had been carefully comparing the length of the arc, the voltage, the current, size of crater, and so forth, but over very much larger ranges, and with more perfect appliances than any previous observer. In particular, they had found that if after adjusting any of the conditions as to length, current, and the like, a sufficiently long time (exceeding half an hour, if I remember aright) were allowed to elapse, the crater and peak settled down to a special form corresponding to those conditions. And that to every change of length or of current there corresponded a different form. Only when each separate experiment—and there were hundreds of them—had been carried on for a sufficient length of time could readings of voltage be obtained which were truly normal. Results obtained in this patient way, when plotted out in curves, showed the most surprising regularity. Instead of the broken curves (such as Frölich's, Fig. 2 *supra*) of the earlier observers, curves of smooth outline were obtained. Also the observations had been pushed further. The

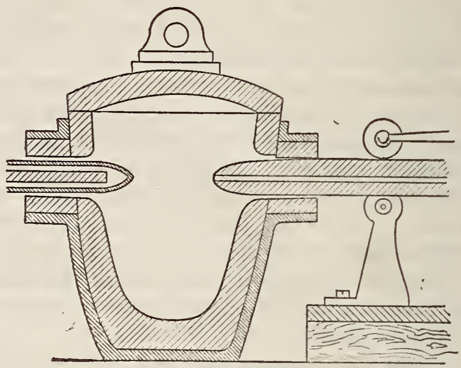
curves had been carried to extremes—for very large currents, and very small currents; to very high voltage, and very low voltage; with very short arcs, and very long arcs; with very big craters, and little craters. Those curves contained by far the most complete account of the natural history of the arc than any other thing attempted by any one else. I looked forward to the publication of these results with great interest. Sad to relate, the scientific man to whom Professor Ayrton entrusted the paper before he left America to return home, after keeping them beside him for some months without sending them to press, allowed his negro servant to use them for lighting fires. Only a few fragmentary notes remain. I have urged Professor Ayrton to renew his labours and repeat investigations of such importance, and I am glad to say that we are likely to have something soon from him to repair the loss. But until that appears I shall feel, at any rate, as though a very large part of the physics of the arc was still wanting.

[*Note added, October*, 1895.—During the course of the current year, Mrs. Ayrton has communicated to *The Electrician* a series of papers embodying the fragments of the research of which the records were so shamefully treated, together with the results of renewed experiments. Mrs. Ayrton has further communicated to the British Association, in Sept., 1895, a paper on the formulæ for expressing the relation between voltage, current, and length of arc. The results of these observations are so important that it would be an injustice to their merits to attempt to summarise them here. Mrs. Ayrton's formula has been added to those exhibited in the Table on page 949.—S.P.T.]

Arc Furnaces.

From the time of De la Rive and of Despretz, experiments have been made on the use of the arc for electrometallurgical processes, owing to its very high temperature and the reducing action of carbon. Napier, in 1845,* presented to the Society of Arts an electric furnace intended for the reduction of metals, consisting of a lined plumbago crucible, into which a carbon electrode was introduced. Sir W. Siemens was amongst the first to revive the construction (Fig. 9) of an arc furnace. He introduced, through the sides of a crucible refractory and non-conducting material, two pencils of carbon, between which the arc was formed. Since then great progress has been made by Cowles in the production of aluminium alloys, and by Moissan and others in the reduction of metals. A wide field for commercial development has thereby been opened.

Fig. 9.



Another thing has to be done; the chemists must go to work. The chemistry of carbon at high temperatures is one of those things that ought really, now that the supply of electricity is so common, to be easy to experiment upon. The electrician provides what the chemist wants, the means of making a high temperature with an arc. What the chemist has not yet worked out is the chemistry of carbon at high temperatures. Thus, we know that chemists have not found a compound yet that cannot be decomposed into its elements at the temperature of the arc in the presence of carbon, so that carbon appears to be the nearest approach yet to the universal solvent. When I deal next week with the optics of the arc I shall recur to this matter of the behaviour of carbon itself; but from this point onwards —that is to say, in my next lecture and in the one afterwards—I do not propose to return to any of the other materials that have been proposed. It simply is waste of time at present to deal with arcs made with any other material than carbon; in fact, I will take this one of the 70 known elements, and confine myself to it. And I will deal with that element in a particular way, viz., as used in the making of an arc at about 40 to 50 volts, leaving aside all high voltage phenomena, all vacuum phenomena, all the abnormal phenomena of the arc, confining myself to the arc as we know it for industrial purposes.

* See *Mechanics' Magazine*, 1845, p. 432.

Journal of the Society of Arts.

No. 2,241. Vol. XLIII.

FRIDAY, NOVEMBER 1, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

TECHNICAL EDUCATION COMMITTEE.

The first meeting of this Committee will be held early in December. Due notice will be given of the date appointed.

Henry Trueman Wood,
Secretary.

INDIAN SECTION.

A meeting of the Committee of the Indian Section was held on Tuesday, 29th October, at 4 p.m. Present:—Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., in the chair; Lionel R. Ashburner, C.S.I., Jervose Athelstane Baines, C.S.I., Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., M. M. Bhownaggree, C.I.E., M.P., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., F. C. Danvers, Major-General Sir Frederick Goldsmid, K.C.S.I., C.B., W. Lee-Warner, C.S.I., Sir James Broadwood Lyall, G.C.I.E., K.C.S.I., Alexander Rogers, Thomas H. Thornton, C.S.I., D.C.L., A. N. Wollaston, C.I.E., W. Martin Wood, Andrew Yule, with Sir Henry Trueman Wood (Secretary of the Society), and S. Digby (Secretary to the Section). The arrangements for the Session were considered.

Proceedings of the Society.

CANTOR LECTURES.

THE ARC LIGHT.

By Professor Silvanus P. Thompson, D.Sc., F.R.S.

Lecture II.—Delivered January 21, 1895.

OPTICS OF THE ARC.

The optical phenomena of the arc are nearly as complicated as are those electrical phenomena which occupied us a week ago. They vary with every different kind of carbon that one may employ, with every different value of current that one may use with a given carbon, and with every different kind of adjustment that one may have in the lamp that regulates the carbon. In a lecture such as this, one can only deal with a few salient facts in a few typical cases.

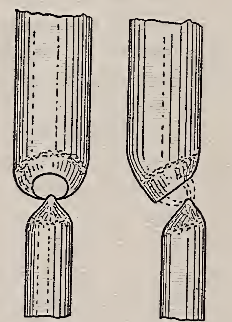
Distribution of Light of the Arc.

The first and most important case to consider is that of the normal arc produced by the continuous current. There are two possible general cases of this also. The first case is that in which the current descends from the upper carbon to the lower, and is generally adopted for the lamps used for outdoor work. The second case, which is rather exceptional, and is only adopted in certain cases of indoor illumination, is that of the inverted arc, where the current ascends from the lower carbon to the upper. As the former is the more usual, we will deal with it. In this lantern we have now an arc formed; the particular regulator employed here being a Serrin lamp of the old-fashioned sort. I use it rather than any more modern mechanism, simply because it is convenient as a table lamp. In front of the arc, which is formed here between these carbons, we have a lens in order to project the view of the arc upon the screen, and we can, if need be, introduce in front of the lens an erecting prism to rectify the position of the image on the screen. You now see upon the screen the image of the arc formed between the carbons. The positive carbon, with its luminous crater, is at the top; the negative, with its characteristic peak, is at the bottom; and in between them is a violet coloured flame or arc, consisting of the column of carbon vapour through which the current descends. By a very small adjustment of the upper carbon, I arrange the position of the points so as to enable you to get a better view of the crater. Here is the first and most obvious optical fact, that the light comes from the white hot surface from which the carbon is evaporating. About 90 per cent. of the light comes from the crater, and about 4 or 5 per cent. from the negative peak; while comparatively little light comes from any other part. Around the rim of the crater there is, however, a region that is less luminous, not so hot, and of a redder colour; and there is a certain small per-centage of light—not more than three or four per cent. of the total light,

at most—emitted from the intermediate flame. Now, of course, there results from this a peculiar destribution of light in the space all round; the light is, in fact, thrown mainly downwards.

When it is desired to throw the light not symmetrically downwards, but to project more of it in a horizontal direction, we resort to the device, introduced first by Duboscq, of displacing the line of the carbons, so that the negative peak instead of being exactly under the centre of the upper carbon, is brought a little forward (as in Fig. 10). The crater then

FIG. 10.

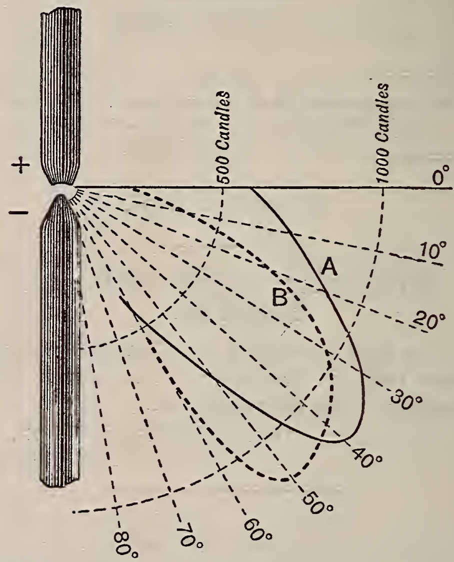


forms obliquely, with the negative peak in front of it. This effect I will now produce by simply shifting the upper carbon backwards. As I gradually displace the upper carbon to one side, the form of the crater will change; the positive carbon will burn away more on one side than the other. It takes a few minutes to change its shape, during which time the light will be unsteady; and when the new form has been assumed, we shall find that the light is thrown mainly on one side, as is desired for projector purposes, and for use in the optical lantern. We may have to let the arc burn untouched for something like half an hour, in order that the final shape of the surfaces may be properly assumed. As the maximum emission of the light is at right angles from the luminous surface, we shall now have obviously a different distribution in the illumination.

DISTRIBUTION CURVES.

For a period of 15 years or more back, it has been customary in the laboratory to measure and plot out the amount of light given by arcs in different directions, and to study the curves of distribution produced in that way. Two examples of these are shown in Fig. 11. Curve A relates to an arc produced at a constant voltage on a low-pressure system of supply. Curve B to an arc produced with an unvarying current on a high-pressure system of supply; other arcs

FIG. 11.



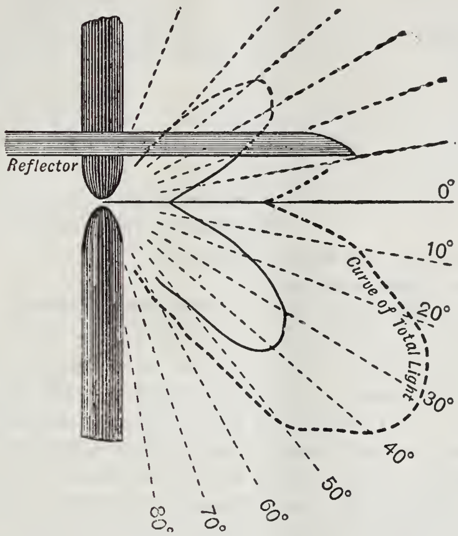
being in series with the one measured. The mean current for both was about the same. The data of the measurements (which are taken from an American source) are given in the Table below.

(A) LOW-PRESSURE.		(B) HIGH-PRESSURE.	
Angle.	Candle-power.	Angle.	Candle-power.
0°	593·7	0°	210·5
10°	712·1	10°	407·4
20°	866·3	20°	687·4
30°	1,094·0	30°	977·1
40°	1,183·0	40°	1,079·0
50°	682·2	50°	1,140·0
60°	495·4	60°	595·7

If we select some photometric arrangement which will enable us to measure the amounts of light given out in different directions horizontally, and at different angles downwards, we can then plot out along these angular directions the amount of light so measured. The distribution-curve, marked B in Fig. 11, shows that a little light is given out in an absolutely horizontal direction; that is because in that direction the lower rim of the crater throws a little light sideways. At an angle of 10° downwards there is a little more light, and

at 20°, 30°, 40°, 50° one finds that there is an increasing amount until you come to the maximum in one particular direction, which, in this case, is about 50° from the horizontal. As you] go further along you find that the light suddenly diminishes, not absolutely abruptly, but very rapidly, while absolutely straight down there is no light thrown at all. Obviously, in that case, there is no light because the bottom carbon and its holder throw a shadow. The curve A, in Fig. 11, is another plot taken from a different lamp, under different circumstances. Let us now compare the curves so plotted with Fig. 12,

Fig. 12.



which shows a plot relating to an alternating current lamp. In such lamps the two tips do not materially differ in form from one another, provided the quality of carbon is alike, and the pencils of equal thickness. Both tips take the form of a blunt peak. This form would be exactly alike were it not for the fact that the hot air ascending at the sides heats the upper carbon more, so that it becomes slightly more coned than the lower one. In this case the black curve represents the amount of light in various directions. Some is thrown downwards at an angle, and almost an equal amount is thrown upwards at an equal angle, with intermediate values in intermediate directions. But if a reflector is interposed to catch the light that is going upwards and throw it also downwards, one obtains the distribution plotted out in the dotted curve.

Dependence of Distribution on Shape of Crater and Peak.

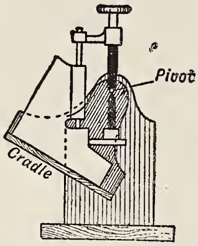
During the minutes which have elapsed, our arc has been steadily burning, and the crater on the upper carbon has assumed the oblique position. The peak remains as a peak, and is visible against the crater surface which it partially hides from our view. The main amount of light (see Fig. 10, p. 962) is now given off in a not quite horizontal direction.

To make experiments on the amount of light given out in different directions, one requires either a photometer capable of being shifted round into all possible angular positions, or some apparatus for turning the arc into different inclinations with respect to the photometer. There is, however, an intermediate possibility, namely, some method of optically tilting the lamp so that its light shall still come to the photometer, no matter what the inclination may be. To enable you to see upon the screen what the arc looks like when viewed at different inclinations, the following apparatus has been devised (Fig. 13, p. 964).

Here is a small projector lamp (made by the Planet Company) for the purpose of magic-lantern work. This little lamp is fixed on a cradle-shaped stand, so that it can be rocked about on horizontal trunnions; the line of axis of these trunnions passing right through the arc. When the arc is burning steadily, while we project its image upon the screen by means of a lens placed in front, we can tilt it to any

angle desired, and set it either vertically, or with any desired inclination towards the horizontal plane. So here we accomplish the same result as viewing the arc obliquely from positions below.

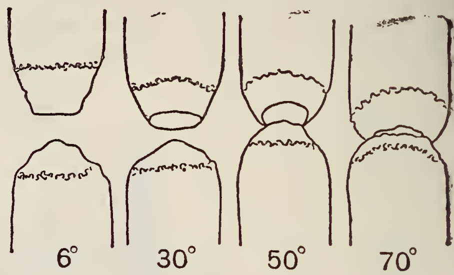
Fig. 13.



If I set the cradle so as to bring the rim of the crater into the horizontal plane, with the carbons vertical, I shall have the arc in the position of habitual use (Fig. 1, p. 947), and on the screen you see the sideway view. You see that very obvious peak, and above it the edge of the white hot crater. If I lengthen the arc a little you will see the peak burn away to a blunter form, while the crater will become flatter. Having now seen the form sideways, I will tilt back the cradle, so that we may get another view of it. The duller spot which you see in the middle of the crater arises from the circumstance that we are employing a cored carbon, that is to say, a carbon with a hole down the middle, packed with carbon of a more or less soft quality, and possibly not quite pure. As the cradle is tilted the negative peak comes in front of the crater, and shows dark against its luminous surface. Turning it to a still steeper angle, so as to get in a horizontal direction the equivalent of the light which would otherwise be thrown obliquely downwards, we find the negative peak almost eclipsing the crater, and cutting off its light.

Fig. 14 shows four views at four different angles, 0°, 30°, 50°, and 70°. In the two extreme positions, where the crater is seen only edgeways, and where it is eclipsed by the peak, there is very little light; but at some angle between these two there will obviously be a position where the light is a maximum. The crater, at first seen edgeways, seems to open out into an ellipse, which widens, until the intruding peak eclipses it. There will obviously be a maximum position between the two minima. For a long time this was not very well explained. M. Rousseau, who made some observations by means of a polar photometer, on the arc lamps shown at the Exhibition

Fig. 14.



at Antwerp, in 1885, tried to express the results by using some long and complicated formulæ.

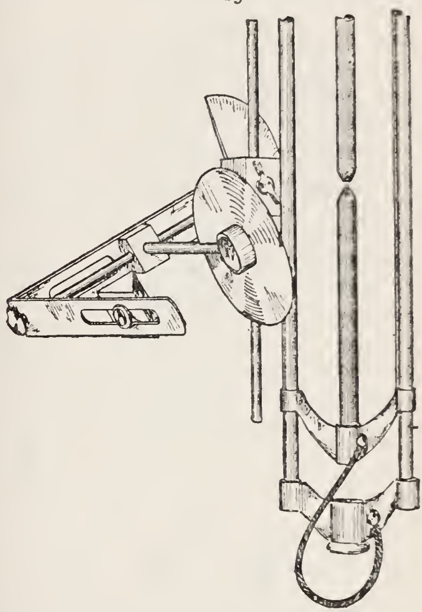
Trotter's Theory of Distribution.

In the spring of 1892, Mr. Alexander P. Trotter, who has done so much in arc lamp optics and physics, showed a much simpler way of treating the matter. He started from the physical standpoint at which I explained in my first lecture I arrived in 1889, viz., that because the arc is a phenomenon due to the volatilisation of carbon, it will have a definite temperature, and, therefore, assuming that temperature to be definite and the carbon to be pure, the light emitted at the crater surface will have a definite whiteness. Starting from that point he argued as follows:—It does not matter for optical purposes whether the crater is actually flat, or whether it is literally of a cup shape, since a luminous surface gives out only as much light in any direction as would be given out by a flat surface of equal intrinsic luminosity having exactly the same outline. This may seem a little strange, because it is contrary to one's experience of surfaces that are not self-illuminating. Take, for instance, an ordinary white saucer illuminated by the sky, or by artificial light. If you set that saucer up in any one particular position, and inquire how much light it throws to your eye as you move round it in different directions, you will find as matter of measurement that the amount of light given out in different directions does not depend simply on the visible size of that saucer, but owing to the circumstance that it receives its light at a particular angle and reflects it, the amount of light given out to your eye by any visible area of its surface depends upon the angle at which you see it.

But where you are dealing with a self-luminous surface this is no longer true. For instance, take a piece of white paper as a sort of model, imagine it to be a white hot surface. Look at it through any definite aperture—for instance, through this tube; you will see a round luminous disc (of a certain size, limited by the aperture). It will not make 1 per cent. difference whether the white surface behind it is absolutely square across, or whether it is turned or tilted obliquely. As long as there is enough white surface behind to extend completely across the visible aperture, the aperture will look equally bright. The angle of incidence to the sloping surface behind the aperture has nothing to do with the brightness. The self-luminous surface is equally bright whether it slopes or whether it stands squarely opposite to the eye. The crater surface may therefore, for optical purposes, be considered to act as a small white hot horizontal disk.

The amount of light that it will emit in any given direction will depend simply, in the first place, on the intrinsic brightness, and, secondly, on the visible area which it presents when viewed in that direction. The more obliquely it is viewed the less is the visible area. The amount of light ought to be strictly proportional to the apparent area as viewed in the direction in question. Mr. Trotter's first point, then, is that the crater, no matter what the actual hollow may be, may be treated as a flat disk suspended somehow or other up in the air, and shining white hot. Then what will be the geometrical distribution of light in all directions from this disk? That will be simply a matter of angle, or, rather, of the cosine of the angle. The disk will appear biggest, at any given distance away, if the eye is placed exactly opposite it. Because when the disk is square across the line of sight, it obviously will subtend the greatest apparent angle in space. It will appear of no size at all in directions at right angles to this, because the disk is edgeways, and the edge has no visible magnitude quantity. There will be no light in that direction; in other directions there will be some light. There will be a maximum in the direction of the normal to the surface; and the amount in any other direction will be simply proportional to the cosine of the angle which that direction makes with the normal. If you take the cosine of the angle as measured from the normal, or the sine of the angle as measured from the horizontal plane, and plot out the values in a polar diagram, as in Fig. 16 below, you will find the points all lie on a semicircle. In brief, cosines plotted as a polar curve give geometrically a circle that passes through the pole. Therefore, if this law were to be literally fulfilled, and if our crater were a horizontal disk up in the air—whether circular in outline or not is immaterial—the amount of light measured in different directions, provided there were nothing to interfere, would plot out simply on a semicircle, giving us the diameter of the semicircle as the greatest amount of light measured down underneath the disc. Unfortunately, the arc lamp consists of something more than a top carbon with a level crater at the end of it.

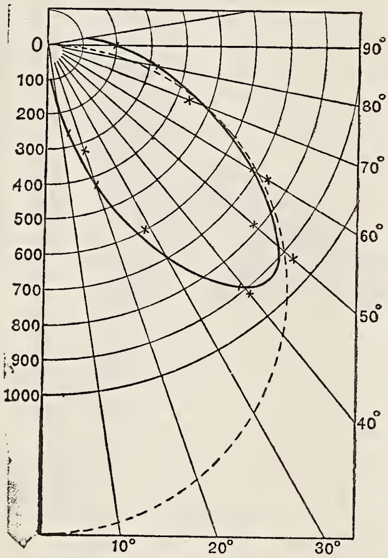
Fig. 15.



There is that unavoidable negative peak which gives out very little light of its own, which is merely being roasted in the heat of the crater above it, and which casts a shadow. If you will measure the amount of the eclipse that goes on in different directions, you will get a measure of the amount of light cut off in those directions from the amount that would be strictly proportional to the cosine of the angle. No sooner had Mr. Trotter conceived this idea, than he was good enough to come and talk it over with me at the Technical College. I put one of my senior students, Mr. C. F. Higgins, at his disposal to devise a little piece of apparatus to test this theory. Mr. Higgins constructed the apparatus used by Mr. Trotter in the investigations which followed. I have the apparatus here (Fig. 15)

fixed on one of the Planet Company's lamps. There is attached to the framework of the lamp the small apparatus by means of which the light given out from the arc in any direction can be examined. A lens is placed opposite the arc at a certain distance away, the light from that lens is received on a small mirror, having its front face metallised. The mirror being set at 45°, sends out the light at right angles, to a distant screen, where the image is received. Then by merely tilting to any desired angle the frame which carries lens and mirror, one can examine, in any direction within wide limits, the visible appearance as presented in that direction. Armed with this instrument one can make photometric

FIG. 16.



measurements of the light sent out at different angles, without moving either lamp or photometer. But of more importance is the fact that by focussing the images on the screen, one can make pictures of the visible forms of the carbons. Putting a sheet of white paper against the screen you project on it any particular view of the arc you like, and then with a drawing-pencil outline the projection on the paper. Having in this way obtained a series of sketches of the arc as projected at various known angles (and all on the same scale) you may then go over each sketch with a planimeter, and measure up the amount of luminous surface that is visible in different directions.

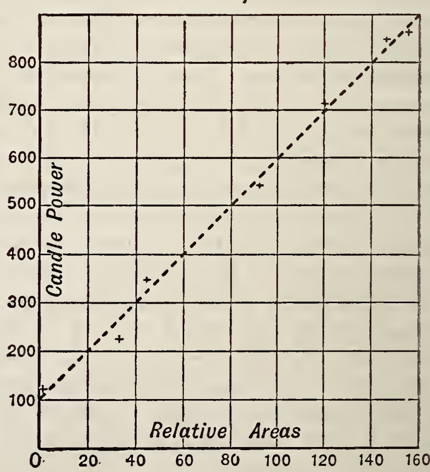
This elegant method of determining the illuminating effect at different angles is a feature of Mr. Trotter's investigation.* In his paper Mr. Trotter gives his results plotted out in the form of curves. In one curve he plotted the intensity of the light as measured in different directions. In another curve he plotted the amount of visible crater area, as measured in the different directions. So close is the agreement, that the curves are scarcely to be discriminated one from the other. Fig. 16 gives the curve of visible areas plotted as a polar diagram. The dotted semicircle gives the values of the cosines, which are proportional to the area of crater surface which would be visible if it behaved exactly as a disk, and had no obstruction in front. The light in any given direction is apparently proportioned to the amount of visible crater area exposed in that direction. This is a very important result, because it enables us to see exactly why the light is distributed as it is. Before Mr. Trotter's experiments there had, however, been some other observations made, dealing with the relation between the amount of light and the amount of current.

* "Journal Inst. Elec. Engs.," 1892, xxi., 360.

Intrinsic Luminosity of the Crater.

Let us proceed to correlate Mr. Trotter's observations on the relation between the amount of light and the crater surface with those earlier observations on the relation between the crater surface and the current.

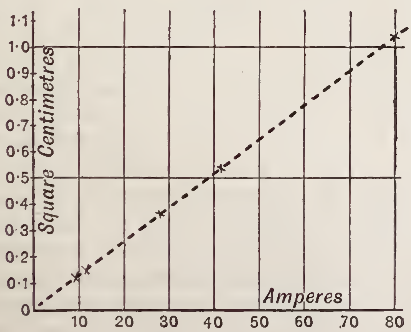
FIG. 17.



We will take, first of all, Mr. Trotter's results, in which we compare together the amount of light, as measured photometrically, and the amount of crater area, as determined by projecting the images on the screen, and measuring them with a planimeter. Fig. 17 gives in graphic form the result of Mr

Trotter's researches on the relation between the candle-power of the arc and the visible area of the crater surface. The candle-power is plotted out vertically, and the corresponding areas of crater surface are plotted out horizontally; they lie practically on a straight line. The main thing substantiated is that, taking a certain datum line horizontally across the diagram at about 100 candles, any amount of light above that datum line is exactly proportional to the amount of area of crater surface. Then what is the meaning of having this datum line above the actual zero of candle-power? It means this, that all the light below that line drawn at about 100 candles, was due to other parts than the crater. That is to say, the total amount of light given out by the negative peak, by the duller red-hot regions around the peak, and around the rim of the crater, and by the flame of the arc, amounted to about 100 candles. If we, then, discount this extra light which strays in from the other parts, we may say that the light given out is strictly proportional to the area of the crater surface. The other result I wished to correlate with this was an observation of Mr. J. D. F. Andrews on the relation between the crater area and the current going through the lamp. This research dates from 1880, before we began to talk about amperes of current, and when we talked about webers. Andrews's researches were on the number of webers of current going through a searchlight, and the amount of crater area as measured in the following way. After the lamp has been allowed to burn steadily for a given time, the current was stopped, and the carbons taken out. The size of the crater was measured up, and from that the area of crater surface was calculated. The observations plotted together, as in Fig. 18, give a straight

FIG. 18.



line which goes right down to zero. The current in these experiments was found to be rigidly proportional to the actual area of the crater. Consequently it follows, from Mr. Trotter's results, that the amount of light given out by a lamp (in any given direction) is also proportional to the current passing through that lamp.

If, then, the light emitted is simply proportional to the effective crater area, it ought to be possible to set down in definite terms the specific luminosity of the arc crater as so many units of light per unit of area. Many years ago, Mr. Hiram Maxim had arrived, I know not by what process, at a similar conclusion. He gave the rough-and-ready rule that you can calculate the total candle-power of a lamp by measuring the diameter of the crater in hundredths of an inch, squaring the number, and then multiplying by 10. This is equivalent to 127,000 candles per square inch, or approximately 200 candles per square millimetre—a figure which is high compared with those of other observers. Abney's values range from 39 to 116; Andrews's from 64 to 170; Trotter's from 80 to 170; while Blondel's value is 160. The number of amperes per square millimetre of crater surface is about 0·78; so that the number of candles per ampere should be over 200. Palaz gives 204 to 240 in the direction of maximum brightness.

It will not, however, do to jump to the conclusion that because the crater area, and, therefore, the total quantity of light emitted, is proportional to current, that doubling the current in any given arc lamp will exactly double the light that that lamp gives out. For, if the current used at first is appropriate for the carbons of the size employed, a double current will be much too great to produce a proper crater, and the pencils will overheat. Moreover, the distance between the tips and the form of the tips will differ, and the distribution of the light will be different, preventing a fair comparison. Palaz gives the empirical rule that for a given lamp and carbons working between 40 and 50 volts, the number of candles ("bougies decimales"), *if measured in the direction of maximum brightness*, is equal to $200\ C + 4\ C^2$, where C is the current expressed in amperes. According to this, a 10-ampere current would give 2,400 candles in the maximum direction, while one ampere would only give 204. (The mean hemispherical brightness is only about two-thirds of the maximum.)

[*Note added, October*, 1895.—Shortly after the delivery of this lecture, Mrs. Ayrton published in the *Electrician* the results of

her measurements of the crater, from which it appears that the current is not exactly proportional to the area of the crater, nor yet to its diameter, but to some power of the diameter between 1 and 2. On examining the curves on which her formula is based, it seems evident that further experiments are needed before the approximate law that the area of the crater is proportional to the current can be condemned.—S.P.T.]

Energy Spent in the Arc.

Before passing away from the relations established above let us pause for a moment to consider the energy question. You may sometimes find it said, and it is perfectly true when you are dealing with a fixed resistance, that the energy spent by a current is proportional to the square of the current. That is, in fact, Joule's well-known law. If you double the current through a given resistance, the amount of energy you have to spend is fourfold; and if you were heating carbon you would perhaps argue that the light would be fourfold. But here we are confronted with the fact that, whatever the law might be supposed to be, when the current is doubled the light is doubled, not quadrupled. The light does not go by the square of the current. There is no paradox or puzzle in the circumstance, if one has once realised that important point developed in the former lecture, that the resistance of the arc is by no means a constant; that if you treat the arc as possessing a resistance, simply then you must say the apparent resistance of the arc for a given length varies inversely as the current. When you double your current, the resistance of your arc becomes halved. If, however, you treat the problem in the other way (which seems more rational), as involving the consideration of a back electromotive force, seeing that the back electromotive force is a nearly constant quantity, you must calculate the work done in another way, namely, as work done in driving a current against the opposing electromotive force. There would, in fact, be no work done at the crater surface if there was not located there something in the nature of back electromotive force. To put the thing in simple mathematical form:—If V represents the number of volts against which you are driving the current (*i.e.* the true back electromotive force of the arc), and C stands for the number of amperes of current, then the work done per second is the product of those two. If we were dealing with a constant resistance, V itself would be proportional to the current; hence the product of the current into V brings the current twice over into the expression for the work done. Where, however, we are not dealing with a constant resistance, there being a fixed voltage to do work against, we must use the law in this shape just given: the work done in driving a current against a back electromotive force is the product of the two. If the voltage against which you are working is a constant, it follows that the power expended is proportional simply to the current, not to its square, a conclusion which is justified by the fact, that the amount of light given out is proportional also to the current, other things being equal.

Influence of Crater in Efficiency of Lighting.

Mr. Trotter's admirable paper deals, amongst many other things, with one very interesting practical point. Some years ago it was proposed by Sir James Douglass—a name so well known in connection with lighthouse work—to employ, for lighthouse illumination and projector lamps, a form of carbon rod, different from that which had been previously used. If I am rightly informed, the old carbons originally used in the lighthouses in Dungeness and elsewhere were made from battery-carbon or retort-carbon, sawn into square sticks about a quarter of an inch each way. They were afterwards replaced by round rods of somewhat larger diameter, and, for very powerful lights, by still larger rods. Sir James Douglass seems to have thought he would obtain a better light, a more central, steady, luminous patch to project through his lenses if he could avoid the wandering of the arc over the large surface of the crater. The wandering of the arc, when the carbons are too thick in proportion to the current used, is one of the things familiar to all who work with arc lamps. If you employ a larger size of carbon rod than is necessary for the size of the crater, that is, proportionally to the current, the crater will not be fully filled with light, but a luminous spot of the light will wander round and round unsteadily in the crater. Then at irregular intervals the crater wall will give way, sometimes on one side, and sometimes on the other, and you have loud hissing and extreme unsteadiness. It occurred to Sir James Douglass that if he fluted his carbons he would obviate the formation of a crater rim; he would, instead, obtain a crater with an edge consisting of points at regular intervals with spaces between, and presumably a

more steady arc. Mr. Meyer has sent me these two specimens of Sir James Douglass's lighthouse carbons. They look to me as if they were taken from an alternating-current lamp. Neither of them has a well-formed crater. There is here a second pair of fluted carbons, intended for a smaller lamp, which have the same peculiarity. Mr. Trotter examined the arcs made by using fluted carbons, and reading between the lines, I judge that he was not favourably impressed with the arc produced under those conditions. The fact is, if you want a good light, you must have a good crater. This I take to be the explanation of the attempt to improve carbons by coring them; that is, by making them tubular, and filling the bore with carbon of a softer quality. This device appears to have a beneficial effect in anchoring the arc, and preventing it from wandering round the crater, by giving it a kind of foothold. The soft core tends, in fact, to promote the formation of a crater, and, consequently, to steady the arc. With very short arcs, and arcs that hiss, the crater is generally very irregularly formed and much deeper as a cup than is the case in the long arcs. The mushroom growth that is observed with hissing or short arcs is formed at the expense, in fact, of material torn up from the bottom of the crater. This is but one of a number of irregular phenomena which really need not engage us further, but must, however, be taken into account in any complete account of the optics of the arc. The rapid changes of colour in the flame, whenever the arc is in an unstable state, are very curious.

Whiteness of the Arc Light.

Another very important point in the optics of the arc is its constant degree of whiteness. It was found by Captain Abney long ago, in 1878 or 1879, I think, that the relative amounts of the radiation of different colours—red, blue, yellow, and so forth—in the arc light are always the same, other things being equal; the arc is, in fact, of a constant degree of whiteness, so much so that for years he has used it as a standard of comparison in his researches on colour photometry. This constant degree of whiteness, so far as it is true, is evidence of constant temperature, or possibly of constant temperature coupled with constant emissivity. It is a curious point that when the arc wanders from spot to spot, in the rapid fluctuations that sometimes occur—about which I shall have something to say presently—the apparent whiteness of the arc remains the same, although the intensity of it may vary, that is to say, one patch may look whiter than another patch by having more light coming from it, yet you do not get a change of colour. You cannot say that it is any redder, any greener, or any bluer, there is simply more light coming from it; so that it appears that there may be something comparable to constant temperature, and yet different emissivities at portions of the same surface.

So three years ago Mr. Swinburne and I, independently, suggested that, seeing the arc is always (or was supposed to be always) of a constant degree of whiteness, the very best standard of white light would be that of a fixed area or patch selected from the crater of the arc (by means of a diaphragm having a very small hole in it). We could desire no more perfect standard of white light than one always equally white and of a fixed size. This suggestion of using a square millimetre, let us say, of incandescent carbon at arc temperature, as the standard of white light, was a very fascinating one. I did my best to have it taken up in Germany by the late Professor Von Helmholtz. The last letter I ever had from him was on this subject. The suggestion has been put to trial both by Mr. Trotter, in London, and by M. Blondel, in Paris. The result of it all is that, fascinating as the idea may be, it will not do; not only are there inherent difficulties at the very high temperature that prevails in getting the light through the small diaphragm placed close up to the arc, but as Mr. Trotter has found, the variations of the light are so extraordinary that at present it seems unlikely that we shall ever in this way attain a true standard of invariable amount.

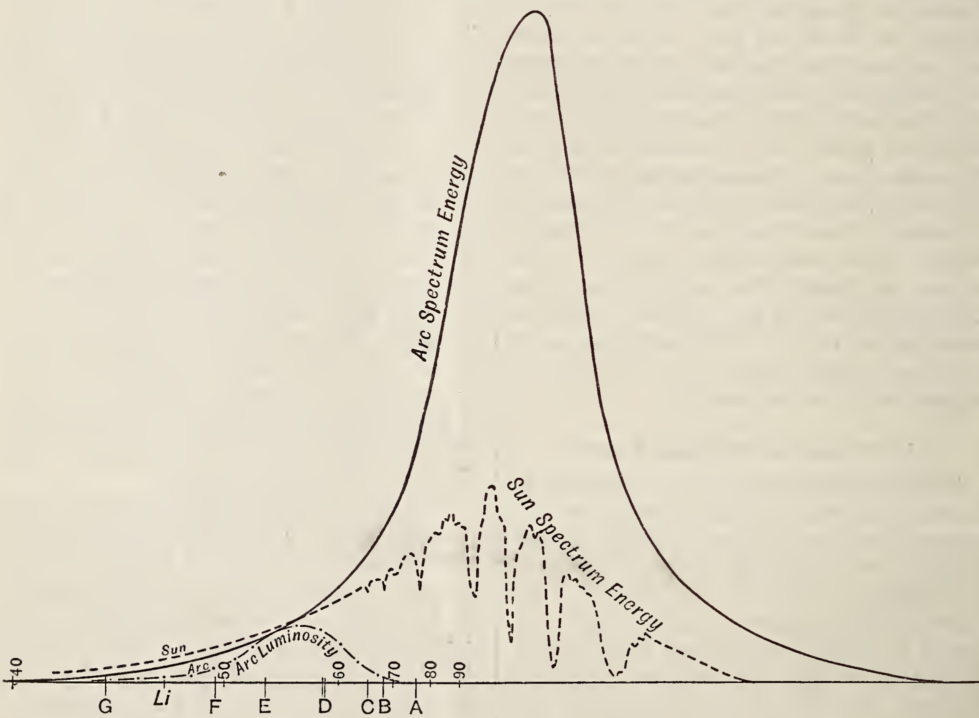
What, then, are these variations about which I am speaking? In the first place, if the carbon contains impurities the light is of lower intrinsic brightness. The soft variety of carbon used as a core in the cored carbons shows as a duller patch at that part of the crater. As an experiment I had an arc light carbon cut down lengthways; there was fixed up against it a pencil made from the best graphite one could get—a pure natural graphite. This combination was, in fact, a carbon rod, half of which was ordinary arc light carbon, and half of which was plumbago. Using this compound rod as a top carbon I found the crater to be unequally illuminated over the two halves. The supposed pure graphite shone less brightly; it was white; but it shone with a different amount of light from the patch of ordinary

arc light carbon, just as the cores of the cored carbon pencils shone with a different degree of brightness. In using cored carbons you, in fact, sacrifice a little of the candle-power in order to obtain steadiness. It is a not unimportant fact that impurities lower either the temperature or the emissivity of the surface, and the result is a want of standard condition. The more recent discovery of Mr. Trotter—presently to be described—is much more upsetting.

Luminous and Non-luminous Energy.

The energy that is given out by surface light is, unfortunately, not given out only as light. There is other energy of a non-luminous kind. I am not exaggerating when I say that only about one twentieth or one twenty-fifth of the energy supplied to the arc, and emitted at the crater, is effective in producing illumination. To put it in a popular way, for every ray of visible light you have given out, you have 24 or 25 rays of invisible light; that is to say, of heat; so that the luminiferous efficiency of the arc is something like 4 or 5 per cent. only. Of the energy spent, there is only some 4 or 5 per cent. which is effective in producing illumination. Here is a diagram intended to illustrate that. Using a proper kind of prism to disperse the rays, one may produce a spectrum. Such a spectrum has been given by various authorities: Müller, Tyndall, Abney, and Langley.* From the recent researches of the three last named I have prepared the diagram (Fig. 19), in which different rays of luminous and non-luminous light are supposed to

Fig. 19.



be plotted out before you. In this case the luminous spectrum occupies a very small part of the diagram. The smallest of the three curves is Captain Abney's curve of relative luminosity or sensitiveness of the normal eye to different kinds of light. The eye is most sensitive to light in the yellow or greenish yellow, and least sensitive to the red, and to blue and violet. What proportion do these radiations to which the eye is sensitive, and which are effective, therefore, for the purpose of illumination, bear to the whole amount of radiation? Only this very small area underneath that curve of luminous energy as compared with the area underneath the tall black curve, which represents the spectrum of the

* Langley, "Researches on Solar Heat" (Washington, 1884), plate xi.

total emission of visible and invisible rays from the arc. Right away down in the *infra* red you have this enormous development of waves of slow period—heat-waves in fact. They are given out in far greater abundance than the waves which affect the eye as luminous waves. The ragged curve which is intermediate between the others, represents to the same scale as the arc spectrum, a spectrum for an equal amount of light, if derived from the sun. It shows how waves of a certain length are absorbed off by the intermediate atmosphere between us and the sun. This curve is taken from Langley. One of the things we have to look forward to in the development of artificial light is the production of lamps which shall be of a higher efficiency than the arc lamp. They must, for an equal amount of energy supplied to them, emit a far greater per-centage of waves of a length that will affect the eye as luminous waves, and a far less per-centage of those longer waves which do not help the illumination, but which only warm us. Such a transformation has been wrought for gas-lighting in recent years in the introduction of Dr. Auer's incandescent mantle. He discovered a material whose emissivity, at the temperature of the gas-flame, is higher than that of the carbonaceous matters in the ordinary flame of coal-gas; it emits a greater per-centage of waves of the sorts that affect the eye, and a lesser per-centage of the non-luminous waves. The vacuum tube lamps, and their modern varieties, such as Tesla's lamps and Ebert's luminescence lamp, are attempts to procure a better specific luminescence from a given amount of energy.

Alternate-current Lighting.

I have on the table here the means of producing an alternating-current arc. The alternating current may be turned on, and then the arc struck by hand between the two carbons. By means of a choking coil I am able to regulate the amount of light given out by the current passing through the arc, and with this lens I will project the arc on the screen, so that you may see the difference between the normal arc, as made with a continuous current, and the alternating-current arc. You will find that, in the latter case, the tips of the two carbons are heated almost equally to whiteness, and assume almost identical shapes. If the carbons are of the same quality, the heating and the consumption of them would be precisely alike, except for the slight difference due to the circumstance that the ascending hot gases around the arc make the upper carbon hotter. The two luminous areas on the two tips are of equal area and equal whiteness, and, as projected on the screen, appear as two luminous patches of equal size; but in neither the upper nor the lower carbon is there either a well-developed crater or a well-developed peak. The fact is, that each tip has to serve alternately as crater and as peak, so that the resulting form is a compromise. We are able then at once to recognise whether the arc is being supplied by a current that is continuous, or by one that is alternating. The distribution of light in the space surrounding the arc corresponds to this difference in the distribution of the luminous surfaces. Whereas the continuous-current arc throws its light (when the crater is at the top) mainly downwards, with a maximum at 40 to 50 degrees below the horizontal, the alternate-current arc throws its light almost equally upwards and downwards, there being two maxima, one above and the other below the horizontal. But with the alternate current it is possible to cause the light to be artifically projected downwards on the whole, either by placing a mirror around the upper carbon (as in Fig. 12, p. 963) to reflect down the light that is emitted upwards, or less advantageously, by employing a thicker top carbon, and a thinner bottom carbon. There is another important difference between the light of the alternate-current arc and that of the continuous-current arc which affords a ready means of discriminating between them. The alternate-current arc is subject to a regular periodic fluctuation. The rapidly-reversing current pulsates, and the arc pulsates too. The current actually stops and then starts again in a reversed direction some hundred or more times in a second. The flame does not actually go out, but it dies down, and before it has had time to go out the current has started again in the opposite direction. If the flame did not thus persist, it would be impossible to operate arc lamps at all by means of alternate currents. I can show you, by a simple experiment, this fact of persistance. I take here a continuous-current arc, and clamp the carbons immoveably at the normal distance apart while the arc is burning steadily. Now, by means of a reversing switch, worked by hand, I suddenly reverse the current. The light blinks at the instant of reversal, but does not go out. An interruption of, say, one-hundredth of a second

does not put out the light: the flame had not time to die away. It is not accurately known what the maximum duration of an interruption may be, but it is known that arc lamps cannot be practically operated with alternating currents, if the frequency is less than about 40 periods per second; that is to say, if there are fewer than about 80 reversals per second. That the light of an alternate-current arc does thus fluctuate can be made evident in the simplest possible way. If one whirls a white rod, or waves it rapidly up and down, in the light of the arc, one perceives a succession of images. When a rod is made to throw its shadow on the screen, and is then rapidly waved to and fro, the shadow is observed to be broken up into a series of maxima. A silver coin tossed into the air shows a succession of images as it falls. By merely shaking my hand in the light of the alternating arc, I appear to possess an enormous number of fingers. The current here used is derived from the generating station at Deptford, where Mr. Ferranti's machines work with a frequency of 85 periods per second. Consequently we have 170 successive images per second for any quick moving body. I have frequently found out whether arc lamps were worked with alternating currents, or by continuous currents, by standing under a lamp-post at night, and twirling my walking stick. You can tell an arc lamp that is alternating by another circumstance, viz., that in addition to any fizzing or hissing that there may be, you hear a kind of continuous hum. In the lamp now before you you may hear the hum of the machines at Deptford. If I increase the current, you will hear it still more loudly. The loudness of the hum also depends on the form of the individual waves of current.

Efficiency of Alternate-current Arcs.

There has been some discussion of late on the question whether the alternating current arc was as efficient as the continuous-current arc, that is to say, whether for a given consumption of energy you obtain an equal proportion of light. Prof. Fleming has made measurements, and written learnedly on the subject. I do not dispute the accuracy of his observations, or that of others who had made observations on the subject. I wish to give you an absolutely *a priori* view. This is a matter I have not measured myself, therefore I am absolutely unprejudiced, but it seems to me perfectly absurd to suppose that, if you take the right mechanism, select the right size and quality of carbon, and use it properly by the light of experience, applying the appropriate amount of current, there will be any difference whatever in the efficiency of the alternating-current arc and that of the continuous current arc. I do not see where there is room for any difference. At one time it was supposed that incandescent lamps were not as efficient if worked with alternating currents as with continuous currents. That heresy was long ago exploded by Professors Ayrton and Perry when they showed that it was merely a question of getting the right voltage appropriate to the measurement lamp. I am bound to say I think the same kind of considerations apply here also. Since the heating effect of a current is proportional to the square of the current strength, what difference does it make, what difference can it make, whether the current is going in one direction or in another? If you spend the right amount of energy on the right amount of carbon, by raising it to the right amount of temperature, you are bound, other things being equal, to have equal results. If you arrange your things badly, so that some of the energy is not spent, as it ought to be, on heating the carbon white hot, I grant you may get a different result; but it seems to me, from *a priori* reasoning, to be absurd that you should not have equal efficiency with the alternating current as with the continuous current.

Spectrum of the Arc.

My next experiment is to project upon the screen the spectrum of the arc. Arrangements are made in the following way:—First of all, the arc is produced inside a lantern; it is then focussed by a lens upon a small auxiliary screen 3 feet away from the arc. This screen has a narrow slit down it, the image of the arc being formed on a slit. Through the slit then there passes out a vertical slice out of the arc. In this slice we shall have a bit of the top carbon, a bit of the arc in between, and a little bit of the bottom carbon—one above the other. The light of this luminous slice is then passed through a prism, and on through a focussing lens, producing on the screen a spectrum of that portion of the arc complete, from the red end on the right to the violet end on the left. Now notice what that spectrum consists of. The upper luminous streak is the white light from the crater spread out into its various component colours in their proper order one after the other. The light of the bottom strip,

which also goes from red to violet, is the light from the peak of the negative carbon. The apparently dark patch in between them shows you the spectrum of the pale flame or arc. Only those who are near can see it properly, but in this comparatively dark tract between upper and the lower carbons the spectrum shows a number of nebulous bands, two in the green, a brighter one in the bluish green, and another one about the end of the blue or beginning of the violet. Those bands are the well-known spectra of the element carbon, so that we have here the optical proof that the flame between the two carbons consists of carbon vapour in an incandescent state.

The Enclosed Arc.

More properly belonging to the subjects comprised in my first lecture is the matter next to be mentioned of the peculiar effect produced on an arc by burning it in an enclosure which prevents access of fresh air. The properties of the enclosed arc have been investigated by Mr. Marks, to whom is due the disposition which I here exhibit. It may be fitted to any ordinary form of arc lamp. The lower carbon projects through, and supports a metal disk with a raised rim, on which stands a small glass jar about three inches in diameter. The upper carbon comes down into this through a rude stuffing-box at the top of the jar. The arc is formed in the usual way, only it happens to be enclosed, so that the air cannot come in from below or readily pass through the rough stuffing-box at the top. The air in the jar is in a few minutes deprived, by combustion, of its free oxygen; so that, from that time onwards, the arc is burning in an atmosphere that will not support combustion. As a consequence, the actual waste of carbon is much smaller than is usually the case. In some experiments on the ordinary arc, made by Mr. Preece, with a Brockie-Pell lamp, using about $6\frac{1}{2}$ amperes at 50 volts, with a 13 mm. carbon for positive, and an 11 mm. carbon as negative, the mean consumption per hour per ampere was found to be, for the positive carbon, 3·52 mm. (length), or 0·504 grammes, and for the negative carbon 2·86 mm., or 0·176 grammes. (Dr. Strecker gives, as the experience in Germany, 0·75 and 0·375 grammes respectively.) Now, this consumption of carbon may, as Mr. Marks has shown, be greatly reduced by simply preventing access of fresh air.

This actual lamp has been tried. My friend, Prof. Walmsley, of Edinburgh, who has been good enough to communicate to me the figures obtained during a run of 14 consecutive hours. The carbons were those ordinarily used in Brockie-Pell lamps, but the actual lamp used was of Brush-Sellon pattern. The current was 10 amperes, and the mechanism was adjusted to give a rather long arc. Of the positive rod the length consumed per pair when burning open was 47 millimetres; when enclosed only 2·84 millimetres. Of the negative carbon, the length consumed per hour, when open was 18·7 millimetres; when enclosed, only 0·62 millimetres. The positive carbon, when burnt in this way, only burns at about 1-10th of the rate at which it burns away in air, while the negative carbon only burnt away at about 1-30th of the rate at which it burns in free air. The total consumption, when enclosed, is, therefore, about 1-20th part of what it would be for the same current when the arc was burning in open air. There is, however, one drawback to the use of an enclosing vessel like this; viz., that the interior of the vessel gradually becomes coated with a brown dust which obscures the light. On that Professor Walmsley made some observations, and came to the conclusion that after 18 hours the light was approximately about half of what it would have been without the globe. As a matter of fact, it is a brown deposit, which cuts off rather more of the green waves than it does of the red waves.

The Trotter Phenomenon.

I now come to the most recent and by far the most important of recently-discovered arc phenomena. Mr. A. P. Trotter has observed a phenomenon in the arc which has so completely changed one's ideas as to the nature of the crater surface, that one needs to reconsider everything previously learnt or observed.

When you project upon the screen by means of a good achromatic lens (such as a camera lens) an image of the arc, and adjust it so as to get a good view of the crater, a little care will enable you to discern, as often as not, somewhere in the middle of the luminous crater—not always exactly in the centre—a nebulous patch, sometimes extending in different directions. This patch is more luminous than the surrounding surface of the crater, over which it moves in a capricious way. Sometimes you can catch a glimpse of this patch revolving, flickering round and round; sometimes it goes round one way, and sometimes the other. You cannot readily observe it, however, unless you resort to artificial

means, because of the rapidity of its motion. So to see it you must have recourse to the stroboscopic method. Take a simple disk of cardboard 8 or 10 inches across. Cut in this a number of equidistant narrow radial slits—say 36, 48, or 60—and blacken the disk to obviate stray reflections. Put a pin through the centre, and fix the pin into a wooden handle. Spin the disk by hand, and watch the arc through the slits. You will then, at moments when the frequency at which the the disks pass the eye corresponds to the rapidity at which the movements in the arc occur, catch sight of the moving object. A second method, suitable for projection of the phenomenon on the screen, is to mount a similar disk upon a small electrically-driven motor right in front of the arc. A suitable frequency is 400 per second, or so. A third method of observation consists in throwing the image of the arc not upon a stationary screen, but upon a revolving disk painted half black, half white.

By the use of each of these methods Mr. Trotter succeeded last summer in proving that in the arc there is a *phenomenon of rotation* of something the precise nature of which is not yet known. The discovery was communicated in due course to the Royal Society.* The essence of the stroboscopic method is that it gives a stationary or slowly moving view of a rapidly moving object. If a thing is revolving so fast that the eye cannot follow it, it may be readily seen if the observer is furnished with an apparatus which will allow the eye only to catch a momentary glimpse once in each revolution. Suppose that just at the instant when one slit passes the eye the revolving thing is in a certain position, and that by the time the next slit has come opposite the eye, the revolving thing has gone exactly once round, the eye will see it as though it had not moved. If the frequency with which the slits pass the eye does not precisely correspond, the revolving object will seem to revolve slowly, either forward or else backward, according as the frequency is either too small or too great. The thing that Mr. Trotter has found in the arc is a white object, having a sickle-shape or comma-shape, extending from some place near the middle of the crater to its edge, and revolving in a singularly capricious manner. The wandering whitish spot that is seen without the use of any revolving disks, is apparently the head of the comma-shaped object, the tail of which moves usually so fast, that its form cannot be seen, except by the use of the revolving slits.

By the kind co-operation of Mr. Trotter I am able to show you this rotatory phenomenon. An arc lamp arranged to be hand-fed is enclosed in a box. In front of the lamp is a small lens to throw an image on the screen, and immediately in front of the lens is a rotating disk of tinned iron, provided with slits, mounted upon the shaft of a small but rapidly revolving electric motor. The slit-disk as it revolves cuts off the light and restores it intermittently. We can vary the intermittences from 200 to 400 per second by changing the speed of the motor. What we have to do is to project a well-formed image of the crater upon the screen, and watch it while the rotating disk gets up speed, until the right speed is attained. We then see a sickle-shaped white patch (Fig. 20), which

FIG. 20.

appears to rotate slowly backwards or forwards about a point as centre, or to stand still, according as the rotating slits go too quickly or too slowly, or keep in perfect synchronism with it. It usually has its centre in the middle of the crater surface, and extends to the edge. It is at the present moment in very rapid rotation; now it apparently decreases its speed, and stops for a moment, so that its shape is clearly visible. It appears as though the luminous part of the crater were shaped like the blade of a chaff-cutter, and whirled round with great rapidity. Now it changes its direction, and goes too quickly to be visible. Sometimes, when the speed of rotation of the object on the crater surface is only half as great as the speed of the disk, you get two views of the sickle-shaped object at opposite sides, forming a double figure (Fig. 20); and sometimes one gets a treble appearance, or even four sickles, meeting like a star in the centre. Supposing you have the rotation well developed, and then alter the current gradually,

* Proc. Roy. Soc., June 21, 1894, lvi., 262.

the speed changes in a perfectly regular way; and yet, supposing there is a given current, and the thing is going round at one particular speed all of a sudden, without any warning whatever, the direction of the rotation may reverse, and yet keep the same rotatory speed. When it reverses its direction of rotation it reverses its form also; the concave edge being always the advancing one. That is one of the most puzzling things in the whole phenomenon. Apparently, with each current there is a particular speed of rotation that corresponds. The rotation is not a mere optical phenomenon of the surface of the crater, for, taking a lateral view of the arc, and examining the flame part between the crater and the peak, Mr. Trotter has found evidence that the flame is itself, from top to bottom, also in a state of rapid rotation corresponding to what one sees in this white sickle-shaped body going round on the crater surface.

Interesting and puzzling as the Trotter phenomenon is, I fear it puts an end to the hope that the crater of an arc lamp might be used as a standard of light.

Recent Observations by Mr. Crompton.

Mr. R. E. Crompton has lately noticed another arc phenomenon which was previously unknown, unless, indeed, it has been casually observed without the reason for it being known. It is the following. An arc may be burning perfectly steadily—of the proper length—everything going on without the smallest hint of any discontinuity, and all of a sudden, for apparently no reason whatever, the arc will enlarge itself flaming out sideways, and the flame will go up round the upper carbon, and lick round it once or twice, and then everything will resume its former condition. Mr. Crompton observed this under the following circumstances. In order to study the feed mechanism of different lamps, and to find out which was doing its duty best, and also to study the properties of carbons with a lamp of any particular mechanism, he took records with a recording voltmeter of the difference of potentials between the carbons of the arc, and obtained a very large number of curves. If a recording voltmeter is put across the terminals of a lamp, and the feeding mechanism sticks, you have a record of the fact by a slight kick in the curve. If the feeding mechanism stops, and the feed does not take place when it ought to do, the arc will lengthen unduly, and the voltage across will rise, and that rise will go on for some time until the feeding mechanism does choose to work. As a general rule, a feeding mechanism which waits too long feeds too much. It overfeeds because it has waited too long, and down comes the voltage suddenly, causing a deal of irregularity before the steady condition of things is resumed. All this will be duly recorded in the irregularities of form of the curve drawn by the instrument. With a more perfect arrangement of feeding mechanism, you will have comparatively small changes in the voltage. Records of this sort enable an engineer to pick out that particular mechanism, or to find the particular adjustment of mechanism which will give the most equable voltage on the lamp, and, therefore, obviously will cause the lamps to burn with the least flickering. Thanks to Mr. Crompton's kindness, I have here a number of these records. In this case the records are taken, not from a variety of lamps with different feeds (good and bad), but from a single lamp with a good feed. The object of this particular set of records was to study the different qualities of carbon in the same lamp. The first record shows a very even line; there are very slight undulations upon it; the feed was doing its duty; the carbon has got burnt down to a short stem, and the rod had descended, as far as the stop would allow it to; the arc became too long; the flame burnt itself out; the potentials rose until the arc broke, and the record stops in the middle of an up-stroke. The next record shows the same quality of carbon in use, but with two strange differences from the previous one. There are a number of small details, which indicate that the feed was taking place at more or less regular intervals. It is a very fair curve, with a number of little nicks in it, which show that the feed had taken place rather more markedly than usual; but at two places in this record there is a great disturbance. In the middle of the comparatively quiescent line there is a sudden irregularity, which then settles down. Now a great disturbance like that may be due to the following circumstances. The particular kind of carbon used was one which had certain impurities in it. All carbons have impurities, but this appears to have had impurities of a particular kind, whether silica, lime, iron, or what, I do not know. When the carbons were examined the following peculiarity appeared. Behind the crater, right up at the wide part of the conical surface, there accumulated, as there usually does accumulate upon the car-

bons of arc lamps, a brownish dust. In the present case, as soon as a sufficient quantity of dust had accumulated upon the base of the cone, the arc suddenly spread upwards, and, like a good housemaid, swept off the dust with a tongue of flame, and then subsided; waited until a further aggregation of dust had accumulated, and then went housemaiding again. Among these records, several of which show this same phenomenon, there are some curious things, one of which illustrates the suitability or otherwise of a particular kind of arc lamp for use in a particular kind of building. In one case, where there are a number of cases of slight overfeeding, the record suddenly becomes very quiet indeed, the curve from that moment onward becoming almost a uniformly straight line. The record is marked as follows:—"*A* to *B* tea time, nobody walking about overhead." The lamp was suspended by a cord over a pulley, and the vibration of the building had caused the feeding to be a little irregular at times; but when there was no vibration the feed was more regular. It is not with all lamps that this occurs. Some lamps burn better in a building where there is little vibration to joggle the feed and prevent it waiting too long. Again, if a lamp is set to work at a certain voltage, and then you use it at a voltage that is wrong, you get irregularity. Here, for instance, is a lamp of which the record at 40 volts is a most beautiful straight line, there is hardly the slightest irregularity, but the same lamp worked at 52 volts across the terminals is highly irregular. There is a regularly recurrent irregularity in the action of the feed at this higher voltage. Again another fact Mr. Crompton has observed by following out these records, viz., that if carbons are left in a damp place where moisture can be slowly and regularly imbibed into the pencils, such a carbon, even although of good quality, may give rise to great irregularities. Here is a very irregular record, for instance, obtained from an extremely good carbon, one of Hardtmuth's make. That same carbon taken out and dried in a stove above steam temperature for two days gives a record which has not a flaw in it. Apparently the warmth of the hot air ascending up from an arc is not sufficient to drive out from a carbon the moisture which has been slowly accumulating in it. It seems to be very necessary, if you would have an arc burn with great regularity, to keep your store of carbons in a dry place.

But this topic does not strictly belong to the optics of the arc, it relates rather to the question of the mechanism of lamps, which is the subject for my next lecture.

Miscellaneous.

THE PHILADELPHIA COMMERCIAL MUSEUM.

The Philadelphia Commercial Museum is a municipal institution, established by the city of Philadelphia. The museum itself consists of collections of natural products from all the countries of the world which have already entered the United States markets, or which may be made available for them, together with samples and cases of manufactured products from foreign countries which may serve as aids to Philadelphia manufacturers. Dr. William Pepper, president of the institution, says that its objects are to bring before American manufacturers all the varied products of the world, that they may make the best selection of materials for their own special interests; to publish all possible scientific and useful information concerning these products which may aid the manufacturer and consumer in his choice, and to place on exhibition manufactured articles and samples, with full information from all markets, which Americans ought to enter or control, and to furnish useful information concerning opportunities in foreign lands to the merchants and manufacturers of the United States. The most important parts of the exhibits from Mexico, Central and South America, Australia, South Africa, and many Asiatic countries, at the World's Columbian Exposition, were, at its close, removed to Philadelphia. These exhibits, with renewals and additions, when necessary, will be permanent features of the museum. Similar products from all other countries have been secured, and are being rapidly added to the collections. The division of exhibits and departments is as follows:—Exhibits according to countries; exhibits according to kinds of products; samples of foreign manufactures; a bureau of information; and a scientific and experimental department. Under the classification of exhibits according to countries, a visitor may study the resources and commercial features of any particular country; the extent and variety of its products; the character of its industries, climate, and soil; the means of transportation and manner of communication with the commercial world, and thus be enabled to derive from the exhibits, maps, charts, and other data collected, valuable information necessary to the conduct of his business. Under the classification of exhibits according to kinds of products, the manufacturer or merchant interested in any particular commodity may find systematically arranged and displayed, samples of the various products which interest him, collected from all sections of the globe, with all obtainable data possible, where-

by he may judge of their commercial value. For instance, the manufacturer of wood will have displayed for his benefit thousands of samples, embracing nearly all the woods of the world, in sufficient size and quantity, and with data necessary for him to determine its value in his particular industry. The textile manufacturer may here find examples of the wools, silks, cotton, vegetable fibres, &c., from every foreign country, comprising the most varied and complete collection of its kind in existence. The collections of hides, skins, leather, tanning materials, &c., are intended to enable the dealers in these products to keep fully posted, as regards the constantly changing condition of the world's markets. The samples of foreign manufactures will consist of a collection of samples of merchandise required in foreign countries, especially the new markets of Spanish America, Australia, South Africa, and other countries, the object being to show to the American manufacturer what his European competitor is doing in the foreign trade of these countries, and suggest to him new lines of goods which he may produce and sell with profit. Novelties and improvements made in European manufactures in standard goods and staples will be promptly reported. Detailed information as to the source, cost of production, selling prices, import duties, manner of packing, patent rights, &c., will also be furnished. For the bureau of information the museum will have correspondents in all foreign countries, men of experience, familiar with the conditions and peculiarities of their markets, who will forward regular reports concerning commercial possibilities and the conditions of trade of their particular localities, thus enabling the Philadelphia manufacturer and merchant to keep in close touch with the markets of the world. Business directories and copies of important periodicals will be kept, and the library will contain books of reference in all languages, statistical reports from all countries, and other publications upon the question of trade. Detailed information will be given to manufacturers, on application, concerning commercial opportunities and the demand for specified products in any locality, together with the reports upon prices, duties, credits, &c. Special efforts will be made to procure early and complete information concerning the plans and specifications of proposed public improvements and private enterprises that may be open to contract. In the scientific and experimental department, a careful study of the scientific value of all products collected will be made. New tanning barks wil be carefully examined. Woods will be studied with reference to their strength, durability, and capabilities of finish; gums and resins will be tested for improved varnishes and lacquer. Many new vegetable fibres will be investigated with reference to new applications; and, in general, new articles will be subject to scientific investigation for the purpose of determining their commercial and educational value. Through the publication of this department, the institution will co-operate and exchange with all other scientific and educational museums of the world. In a communication from Dr. Pepper to the United States Department of State, he points out that the institution is strictly a municipal one, and is practically a department of the City Government. It is under the direction of, and supported by, the city, whose faith was officially pledged to the care and maintenance of the collections. In reply, the Department of State has signified its willingness to furnish any information received from diplomatic and consular officers which would serve the purposes of the museum.

CENSUS OF JAPAN.

According to the official returns, on December 31, 1893, the population of Japan was 41,386,265, of whom 20,905,359 were males, and 20,480,906 females. Classified according to social position there were 3,905 nobles, 599 being heads of houses, and 3,306 their families; 2,024,310 "shizoku" (old hereditary official class) of whom 432,723 were heads of houses, and 1,591,587 their families. The proportion of males and females differs according to rank. Among the nobles women predominate by as much as from 10 to 17 per cent., varying between these limits from year to year. Among the gentry, there are about 99 females to every 100 males, while in one year the former predominated by 25 in every 10,000. Among the plebeians, the males are in excess of the females by about 3 per cent. There were 7,859,218 houses. Compared with 1892, this shows an increase in the population of 296,325, and in houses of 41,648. The number of births during 1893 was 1,177,623, of which 601,921 were boys, and 575,702 girls, while 108,872 were still-born; the birth-rate is a little less than than 3 per cent., while the death-rate is a trifle over 1 per cent. There were 357,913 marriages and 116,636 divorces. In other words, one out of every three marriages proves a failure; 35,550 persons were known to be abroad, and there were 296,885 absconders.

Notes on Books.

THE LIFE OF SIR HENRY HALFORD, BART., G.C.H., M.D., F.R.S., President of the Royal College of Physicians. By William Munk, M.D., F.S.A. London: Longmans, Green, and Co., 1895. 8vo.

Sir Henry Halford was President of the College of Physicians from 1820 until his death, in 1844, and the acknowledged head of the medical profession. He was also physician to four successive sovereigns, viz., George III., George IV., William IV., and

Queen Victoria, and it was through his influence at Court that the college obtained the grant of land in Pall-mall East, upon which the present building was erected, from the designs of Sir Robert Smirke. The former home of the college, in Warwick-lane, was found to be very inconvenient to the members, from its situation in the City, and the removal to the centre of the West-end was found to be a great advantage. The opening ceremony was held on 25th June, 1825, when the president delivered an eloquent Latin oration to an audience, "such as in respect of royalty, nobility, official station, and learning, had never before, nor has since, been collected in the college." Although it is over 50 years since the death of Sir Henry Halford, his name is not forgotten, but ranks among those of the most honoured of the presidents of the college. Dr. Munk, whose invaluable work, "The Roll of the College of Physicians," has been of the greatest assistance to historians and biographers, was specially requested by the college to write this life of Sir Henry, which contains a full account of the distinguished physician's connections with his numerous influential patients, and includes many letters from members of the royal family, statesmen, and others.

Sir Henry Halford was the second son of Dr. James Vaughan, and he assumed the name of Halford in 1809. A few years later he succeeded to the property of his maternal relative, Sir Charles Halford. His father gave his sons an excellent education, and two of them, like Sir Henry, made their mark in the world—these were the Right Hon. Sir John Vaughan, a Justice of the Common Pleas, and the Right Hon. Sir Charles Vaughan, Ambassador to Constantinople. At the early age of twenty-seven, Halford became physician extraordinary to the king, and from that time, to the end of his career, his life was a continued success. Dr. Munk gives a notice of Halford's professional receipts from his first year, 1792, when his income was £220, to his 18th year, 1809, when it was £9,850.

THE SLIDE RULE. By C. N. Pickworth. Manchester: Emmott and Co.

This little manual is intended specially for users of the Mannheim type of slide rule, though the general description will be found useful by those who are accustomed to the older forms. The general principle of the slide rule is very clearly explained, and there are a number of examples of its application to numerous technical purposes.

THE TELEGRAPHISTS' GUIDE. By James Bell. London: "Electricity."

This is a reprint from the technical Journal *Electricity*, and is intended for the assistance of telegraphists who have to pass the technical examination of the Post-office. The instruction given is of a practical nature, and there are a number of questions of the character of those set in the above-mentioned examination, and of those of the City and Guilds Institute Examination.

ECONOMIC MINING. By C. G. Warnford Lock. London: Spon, 1895.

Mr. Lock calls his treatise "a practical handbook for the miner, the metallurgist, and the merchant," and in his preface he claims that by the exclusion of matters having only an academic or historic interest he has gained space "for dealing with just those points which, while perhaps not of a strictly scientific value, have nevertheless a high economic importance, and go far towards determining the profitable or unprofitable result of an undertaking." The first part of the book deals with mining and metallurgical operations generally—prospecting, power, drilling, blasting, shaft and well-sinking, ventilation, lighting, draining, mining and winning, hauling and hoisting, reducing, concentrating. The second part treats of non-metalliferous minerals, and the third of metalliferous minerals.

MOTIVE POWERS, AND THEIR PRACTICAL SELECTION. By Reginald Bolton. London: Longmans. 1895.

Mr. Bolton has collected and arranged a very large amount of information relating to motors of every class, and arranged it in such a form as to make it available, not only to engineers, but to the very numerous class who use motive-power, and may have to decide with or without expert advice upon the description of prime mover likely to suit their requirements. The sources of power dealt with include human and animal power, wind, water, steam, exploded gas, and electricity. The very numerous class of motors devised to utilise one or other of these prime agents seem all to be referred to, and their several advantages and disadvantages pointed out. One section of the book also deals with the choice of a motor, and the considerations which should govern such choice. Special types of engine are also described, and, in some cases, approximate cost is given.

General Notes.

MUNICH ART EXHIBITION, 1897.—The Lords of the Committee of Council on Education have been informed through the Foreign-office that the seventh great International Art Exhibition will be held at Munich in 1897, under the patronage of H.R.H. the Prince Regent of Bavaria, mainly on the lines of the rules of the Exhibition of 1892. Further particulars are promised in due course.

Journal of the Society of Arts.

No. 2,242. Vol. XLIII.

FRIDAY, NOVEMBER 8, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Forty-second Session will be held on Wednesday evening, the 20th of November, when the Opening Address will be delivered by Major-General Sir John Donnelly, K.C.B., Vice-President, and Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made :—

November 20.—Opening Address by Major-General Sir John Donnelly, K.C.B., Chairman of the Council.

November 27.—"Locomotive Carriages for Common Roads." By H. H. Cunynghame.

December 4.—"On Mural Painting, with the Aid of Metallic Oxides and Soluble Silicates." By Mrs. Anna Lea-Merritt and Prof. W. C. Roberts-Austen, C.B., F.R.S.

December 11.—"Water Purification by means of Iron." By F. A. Anderson.

December 18. — "Machines for Composing Letter-press Printing Surfaces." By John Southward.

Papers for meetings after Christmas :—

"Dairy Produce." By George Barham.

"The Making of a Great University for London." By Prof. Silvanus P. Thompson, D.Sc., F.R.S.

"Some Native Irish Industries." By Prof. Haddon.

"Standards of Light." By W. J. Dibden, F.C.S.

"Ortho-Chromatic Photography." By Capt. W. de W. Abney, C.B., F.R.S.

"The Garden in Relation to the House." By F. Inigo Thomas.

"English Book Illustrations, 1860-70." By Joseph Pennell.

"Punjab Irrigation, Ancient and Modern." By Sir James Broadwood Lyall, G.C.I.E., K.C.S.I.

"The Economic Development of Kashmir." By Walter R. Lawrence, I.C.S., C.I.E.

Indian Section.

The meetings of this Section will take place on the following Thursdays, at Half-past Four o'clock :—

January 16, February 13, 27, March 12, April 23, May 14.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four o'clock :—

January 28, February 18, March 3, 17, April 21, May 5.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

January 14, February 4, 25, March 10, April 14, May 12.

Cantor Lectures.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock :—

W. Worby Beaumont, M. Inst. C. E., "Mechanical Road Carriages." Three Lectures.
December 2, 9, 16.

Dr. J. A. Fleming, F.R.S., "Alternate Current Transformers." Four Lectures.
January 20, 27, February 3, 10.

Prof. J. M. Thomson, F.R.S.E., "The Chemistry of Metals and Alloys employed for Building and Decorative Purposes." Three Lectures.
February 17, 24, March 2.

H. Graham Harris, M.Inst.C.E., "Refrigeration." Three Lectures.
March 9, 16, 23.

Henry A. Miers, M.A., "Precious Stones." Two Lectures.
April 13, 20.

James Swinburne, "Applied Electro-Chemistry." Four Lectures.
April 27, May 4, 11, 18.

Juvenile Lectures.

Two lectures, suitable for a juvenile audience, will be delivered on Wednesday evenings, the 1st and 8th of January, at Seven p.m., by Prof. John Milne, F.R.S., on "Earthquakes, Earth Movements; and Volcanoes."

Proceedings of the Society.

CANTOR LECTURES.

THE ARC LIGHT.

By Professor Silvanus P. Thompson, D.Sc., F.R.S.

Lecture III.—Delivered January 28, 1895.

MECHANISM OF ARC LAMPS.

In the six years that have elapsed since I had the honour of reading a paper on this subject before the Society of Arts, in March, 1889, a great deal has been done to develop the mechanism of arc lamps. On that occasion there was circulated among the audience a schedule of the various parts of the arc lamp, or, rather, of the various things for which mechanism has to be provided. This schedule is now reproduced in a more extended form.

A few words of explanation are needed as to the meaning of some of the expressions used. By "kinematic train" is meant the particular mechanical device that holds the carbons from feeding until freed at the proper time. "Moderating" mechanism is instanced by the dash-pots and the fan governors found in some lamps. "Replacement" refers to such arrangements as there may be for replacing the carbons when burnt out, "change over" to the mechanism for bringing a second pair of carbons into play.

SCHEDULE OF PARTICULARS OF THE........................ARC LAMP.

Nature of Supply.—......................; ....*amperes;* ....*volts at terminals.*

Resistances.—*Main-circuit coil,*.........*ohms; shunt-coil,*.........*ohms; cut-out,*.........*ohms.*

A	*Driving power*	
B	*Kinematic train*	
C_1	*Striking (electrical)*	
C_2	,, *(mechanical)* ..	
c	,, *adjustments of*..	
D_1	*Feeding (electrical)*......	
D_2	,, *(mechanical)*....	
d	,, *adjustments of* ..	
E	*Moderating*	
F	*Replacement*	
G	*Focussing*	
g	,, *adjustments of*	
H	*Change over*	
I	*Cut-out*	
K	*Cut-in*	
L	*Path of Main-circuit*	
M	*Path of Shunt-circuit*....	
N	*Carbon-clamps*	
O	*Globe-fittings*	
P	*Special Features*	

In nearly all modern lamps gravity is used as the driving-power. The weight of the upper carbon in descending, or that of its rod or attachment, is in almost every case the motive-power in the lamp for propelling the parts. The kind of mechanism or kinematic train that is employed seems to be gradually simplifying itself. In the former paper the typical varieties of mechanism in use were considered in detail. There was the rack, and the train of wheels driven by it; there was a method of having a clutch or a clamp on a carbon rod; there was the method of employing a brake-wheel, or a clutch-wheel, so common in English lamps; there was the method of feeding by means of a screw which could propel the carbons towards one another, or separate them; there was the cord and pulley. Also there were certain other more special motions; for instance one very beautiful one, using a small electric motor to drive the carbon. Then there were various ways of arranging the "feed" to take place by vibration, or by some periodic action similar to the striking or chiming mechanism of the ordinary clock. There were attempts at making continuous feeds, so that the carbons should always be in motion slowly approaching one another, all the regulation needed being effected by the lamp itself, which altered the speed to make it a little quicker or a little slower when necessary. Then there were some hammering feeds employing a method of propelling the carbon, or something that held the carbon, by definite blows through the clutch which held the carbons apart. All these mechanisms persist, but some are much more favoured that others, in the lamps that have been introduced since that time.

Some Early Arc Lamps.

It may be convenient here to introduce a picture or two relating to the mechanism of lamps in general. The first will be a very old one, an invention of W. E. Staite, a man whom the electrical profession has never recognised as he deserves to be; one of the pioneers on the whole subject of electric lighting, and inventor in 1846 of the first automatic mechanism for regulating the arc. Staite produced not one but something like a dozen different forms of mechanism for lamps. In 1867 he had an arrangement equivalent in principle to some of those mechanical devices which have found favour of late. He fed the lamp from the bottom. The lower carbon was caused to be lifted up either by a weight going over a pulley with a cord fastened at the bottom, or by a float. Fig. 21 shows the rod for holding the lower carbon, with ratchet-teeth cut in it. These teeth are caught by a pawl pivotted to the top of an iron tube which surrounds the rod, the whole being surrounded by a series coil, which, when actuated by the main current, sucks down the iron tube against the constant upward force. As the carbon burned away and the current diminished by reason of the arc lengthening the tube slowly rises, and, of course, with it the clamp with its carbon. Presently the extension of the pawl is pressed against the inclined plane at the top, releasing the clutch, and the lower carbon is moved upwards. Another somewhat similar device which Staite had in 1852 is worthy of notice. In this case (Fig. 22) there was also a tubular core sucked down into a solenoid; the core being absolutely supported by a spring and a balance weight. The rod passing through it was clamped by a peculiar clutch, the tail of which caught against a little wheel. The current in the coil, when turned on, pulled this down, pressed the curved arm against the wheel, and, therefore, pressed one end against the rod, and drew the rod down a little bit, so striking the arc. When the current in the main circuit became weakened, the curved brake-piece rose and released the carbon, which was allowed to slip up a little bit and feed the arc. It is a complete foreshadowing, only upside down, of some clutches which have been used in quite recent years. Looking at this device of Staite's, and remembering that he also had a most beautiful wheel-work lamp in 1846, with a differential gear to turn a screw-feed one way or the other, we see what a relatively crude thing it was that Foucault

Fig. 21.

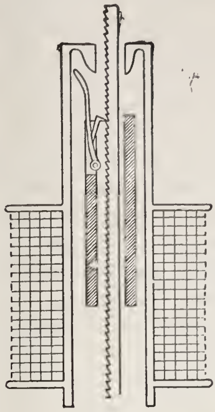
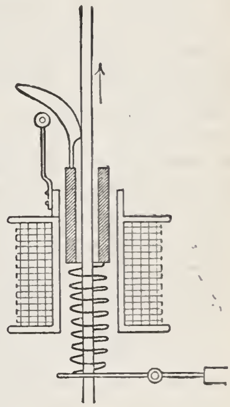


Fig. 22.

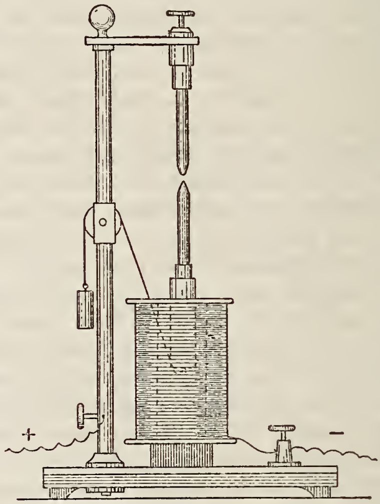


brought before the world* in 1849. In Foucault's lamp the carbons were horizontal, and were made to approach one another by running on two little trucks; the position of the trucks being governed by cords running over a pulley, one being set by hand, and the other one, which moved towards it, being allowed to advance by a cord which was wound up on wheel-work geared to a double train of wheels inside a box. That box had to be wound up by a key like ordinary clockwork, and, having a differential train of wheels, was governed by an automatic arrangement of an electro-magnet, with an equaliser on the armature, and working against a spring. If the strength of the current were exactly right to balance that spring an arm which went up vertically from the pivot stood in a perpendicular position. If the current was too strong naturally the arm would be turned one way, and if the current were too weak the spring would bring it the other way. The position of this arm determined the question whether the train of wheels inside the box should turn to the right or to the left, whether in fact the carbon should be allowed to advance or retreat; or to move neither way if the current was exactly right. Foucault added a beautiful variable resistance produced by two triangular and diverging pieces of metal dipping into water. As they were raised up near the surface, not only did they offer for conduction a diminished surface, but there was an increased distance between them. The whole contrivance constituted electrically an extremely beautiful arrangement, but mechanically was about as bad as could be conceived, the parts were so diffuse.

In developing this apparatus in later years, after the Serrin lamp had been introduced, Foucault was aided by the mechanical genius of Duboscq. In the well-known Foucault and Duboscq lamp of 1863† there was combined in good shape everything except the variable resistance that there was in the primitive arrangement; the carbons to be propelled towards one another, the differential train of wheels requiring to be wound up by a spring, and the lever which would let off one or other end of the train of wheels, and allow the carbons either to approach or separate, according to whether the current was too weak or too strong.

If one returns to the historical development of this subject, the next lamp in order was devised by the architect Archereau, of Rouen, about 1848 or 1850. He had a solenoid with an iron core, acting against a little weight, as shown (Fig 23). The weight would bring the carbons

FIG. 23.



together, and the solenoid would part them. A lamp like this "pumps" very much; it moves up and down, and there is a great flickering in and out when starting; but when you once get it set, it may feed very satisfactorily. This may be regarded as the forerunner of all the electric lamps; there is no clockwork; the action merely depends on the balance between gravity, and the pull of the electromagnet.

Now let us go at once from these ancient things, which I have merely taken as typical of their kind, to lamps current in 1889. In the closing remarks of my lecture on that occasion I referred to two or three types of lamps, as being characteristic of the respective countries, and the last sentence ran thus:—

"In conclusion, it may be pointed out that there exists a curious sort of family likeness between the several members of the three species of lamps most in use. The rack-train lamps, which may be considered as the prevailing Continental type, are, for the most part, in their design and construction, clockmakers' lamps; they have a horological aspect. The clutch-lamps, so universal in America, have a sort of sewing-machine look, the working parts being only finished where necessary for actual work, all else being left rough, or merely painted over. The clutch-wheel lamps favoured by British inventors

* See Foucault's own article on "Electric Lighting" in the "Dictionnaire des Arts et Manufactures," 1852. It is reprinted at p. 317 of the "Recueil de Travaux Scientifiques de Léon Foucault," edited by M. Gariel (Paris, 1878).

† See "Travaux Scientifiques de L. Foucault," p. 322.

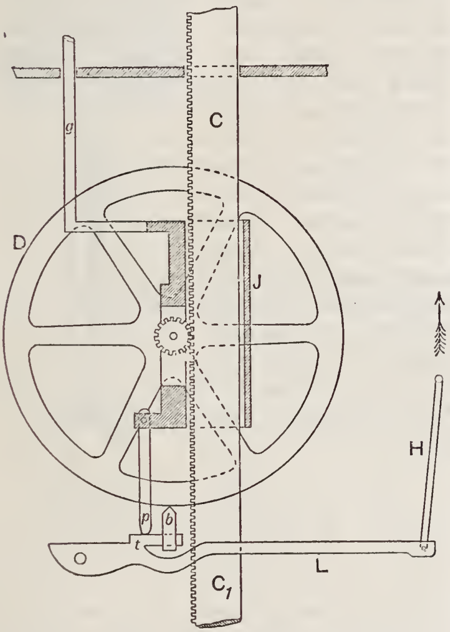
have, in contrast to these, a look as though they had been designed and constructed by a trained engineer; they are essentially engineers' lamps."

That was justified by the comparison of the earlier rack and train clockwork lamps and the American type of clutch lamps, and two in particular of those which had been developed on British soil; and of those two lamps I reproduce the essential features here.

Two Modern British Lamps.

The first lamp is the lamp which Mr. Crompton, in conjunction with Mr. Crabb, perfected about that time. The principle of its mechanism will be seen from Fig. 24. On

Fig. 24.



the carbon-rod is cut a rack which drives a brake-wheel, or rather a pair of brake-wheels one behind the other on the same pinion. The arbor bearing is not fixed in the frame of the lamp, but passes through a short sleeve or jockey, which, when the wheel is free to turn, can slide up or down the carbon-rod, but is prevented from turning sideways by the guide-pin, *g*, above. Below the brake-wheels is a lever, L, pivotted at *o*, and attached by a link, H, to the core of the solenoid overhead. This lever carries a small table, *t*, and brake-piece, *b*, faced with phospor-bronze. When the lamp is out of action the free end of the lever is down, and the weight of the wheels and the carbon-holder bears down upon the table, *t*, by means of the pin, *p*, which projects from the jockey-sleeve. In this position the wheels do not touch the brake-piece, *b*, and are free to rotate so that the carbon-rod is free and the carbons are together. When the current is turned on, the main current coil attracts its core, first drawing up the lever, which turning on its pivot as it rises, brings the brake-piece against the rim of the brake-wheels and prevents them from rotating. Any further rise of the lever lifts the brake-wheel jockey and carbon-holder, thus striking the arc. As the arc burns away and the shunt coil comes into action, the lever descends slowly feeding the arc as required, and before it gets to the end of its tether the brake-wheels are released and feeding takes place by the release of the carbon-rod, the inertia of the wheels preventing any jerky motion.

Contrast that with the corresponding part of the well-known Brockie-Pell lamp. That lamp was already at that time a famous lamp, and has more than justified its existence since. It had also a brake-wheel, driven straight off the rack of the carbon rod; and the brake that played against this wheel was a small projection, with a bit of leather or india-rubber round it, which was pressed in against the inner side of the rim of the wheel. There was loosely pivotted to the same centre a large sector piece, which, as a matter of fact, was weighted, to make it heavy; and upon that sector piece there was pivotted an auxiliary lever, which was worked by a see-saw overhead, the see-saw itself being operated by two cores, which ascended into a solenoid. One core, in a main circuit solenoid, pulled up, and the other core, in a shunt solenoid, opposed it. Suppose the main current is very strong at the moment of striking the arc, this core is pulled violently up. The first thing that happens, then, is that the auxiliary lever is caught at its tail by a fixed piece, and turns round on its pivot, raising the weight, and clamping the little brake-piece against the interior part of the wheel, and then, if there is any further rise, they rise solidly together; that is to say, the auxiliary lever, the heavy sector, and the wheel all rise together about a centre, and raise the carbon, and strike the arc; in fact, one has a kind of internal toggle-brake against the rim of the brake-wheel.

About this time Mr. Brockie modified his mechanism, and put the little brake outside instead of inside, and he has made various detailed improvements since, and has brought out several patterns of lamps. Here is one of

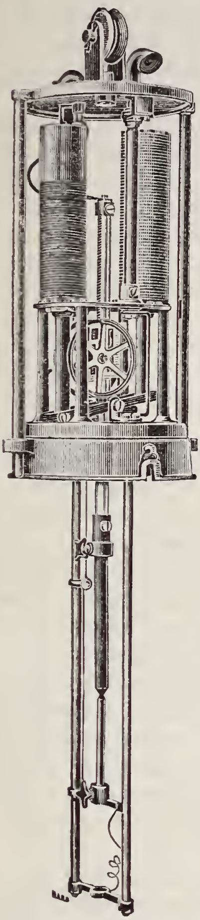
the forms of brake-wheels now employed in one of the many lamps made by Messrs. Johnson and Phillips, under Mr. Brockie's superintendence. In this case the upper and lower carbons are carried by flexible cords, which pass over two pulleys rigidly fastened together, but electrically insulated at the back of the wheel. The wheel in this case is put at the top of the mechanism of the lamp, instead of being at the bottom. The electrical action has to perform the following function. When it attempts to raise the long lever which is sprung across the middle, the little auxiliary lever causes the brake-piece to bite against the inside; they are gripped together tight, and the whole thing has to go round together. When the long lever is let down, however, owing to the small auxiliary lever descending with its tail upon a fixed point, the grip is released, the wheel can turn, and the arc can feed little by little as the motion allows the wheel to turn. To strike the arc it has to turn a little backwards; to feed it must be allowed to creep forward as wanted by imperceptible degrees. A similar sort of arrangement of a clutch against the moving part Mr. Brockie has used in another pattern kind of lamp, which is favoured by the Post-office, wherein there is no brake-wheel; the clutch works in that case on a perpendicular rod.

I believe that all the inventors of arc lamps go through a species of evolution themselves. Take almost any one of the many names in arc lamp work—take Mr. Brockie as an example, or Mr. Crompton, or almost any other—and you will find that the inventor is never satisfied with his first performance. He is impelled to go on, and the record of almost any one of these men will show that they have tried successively various types, and have gone on, sometimes on one line, sometimes on another, developing and perfecting, until they got something very near perfection indeed. The brake that Mr. Brockie has in this lamp is, I suppose, about as near perfection for minute feeding as any brake applied to the rim of a wheel could possibly be. I alluded just now to one feature of the Brockie-Pell lamp—the use of the see-saw piece. This see-saw is a lever operated by two iron cores going up into solenoids, one of which is included in the main circuit, while the other is joined as a shunt. It was no new thing in 1889 to have a differential motion in a lamp. The first one was about 1855. The well-known Brush arc lamp had differential winding on the electro-magnet, the series and shunt coils working against one another. Even earlier than that Siemens had a differential solenoid working at the two ends of a straight core; the series coil trying to pull the core down, the shunt coil trying to pull the core up; but so far as I am aware the special advantage of this see-saw arrangement with a shunt at one end and a series at the other was in 1889 not generally recognised. True it existed in the Thomson-Houston lamp, and in the Brockie-Pell, but scarcely in any other lamps. Now the real advantage of using a see-saw over a differential winding or over a differential plunger is this: that in this case when both the opposing parts are fully in action, when the main circuit coil only is pulling hard at a, the shunt coil is pulling hard at b, the lever is subjected to considerable forces, nearly balancing one another, and any small difference arising from any change of the current in either coil would be quite sufficient to produce the required movement action. Even if there were friction in the parts the movement will occur with certainty because the forces balancing one another are comparatively large mechanical forces. Whereas in the American plan of using a differential winding, when the two coils have their magnetising effect nearly in balance, the magnetism is almost zero and, therefore, the forces are almost zero; and hence the mechanical effect is comparatively at a disadvantage in contending with any tendency of the mechanism to stick. Friction plays a much more important part in determining whether the feeding apparatus is or is not to act in those lamps where you do not utilise to the full the mechanical value of both the currents, that in the main circuit coil and that in the shunt coil. Here, in the see-saw, they are utilised to the full. It is quite remarkable how the see-saw mechanism has, since 1889, grown into favour with other inventors. Kent's lamp, for instance, has a see-saw. At one end there is a shunt electro-magnet, and at the other a series electro-magnet. The see-saw is between the two, so that the mechanical pull of both coils is utilised to the greatest extent.

In Fig. 25 (page 985) we have the Crompton-Pochin lamp—of which the brake-wheel part is practically identical with the Crompton-Crabb brake-wheel (Fig. 24); but instead of having a long solenoid, with an iron core, to be pulled by a lever, there is a series coil and a shunt coil at the top of the lever working the see-saw. One might point to other lamps of

modern type, in which the same see-saw arrangement has survived the less effective forms. In the latest Crompton-Pochin lamp the see-saw operates a band brake. The lamp hanging before you is the form of lamp now produced by the Brush Company, under the name of the Brush-Vienna lamp. I believe the greater part of its mechanism is due to Mr. Kremenetsky, of Vienna. It has a series coil, and a shunt coil, and a see-saw working between them. As in many other Continental lamps in which clockwork or wheelwork is still employed, the operation of the electromagnets of the lamp is to rock over the clockwork bodily, both for striking the arc and for determining whether the feed shall occur or not. You will find that in a very large number of lamps that have developed of late years, the question whether the train of mechanism shall or shall not be permitted to turn is made to depend on the position of the wheelwork as a whole, and the wheelwork is turned round on some convenient axis. One's mind travels back to 1882, at the time of the Crystal Palace Exhibition, when there was a lamp with tilting clockwork in it, shown by Mr. Brockie; a lamp which was never extensively employed, because Mr. Brockie went on to higher things.

Fig. 25.

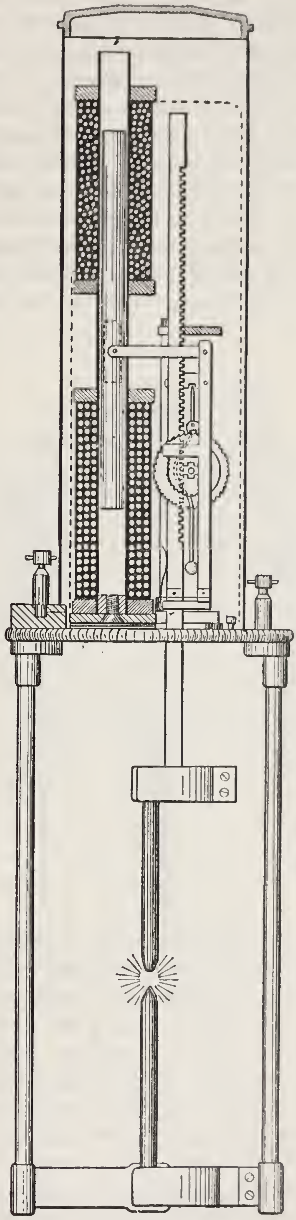


Development of Siemens' Lamps.

We have here, amongst other pictures, a whole series of German lamps developed by the house of Siemens, illustrating the progress of invention so far as that firm* are concerned.

In one of these (Fig. 26) the differential principle is introduced. The upper carbon is supported by a rod on which teeth are cut, which engage with a small pinion mounted on a frame. The pinion is only allowed to turn by driving a pendulum by means of an escapement, so that the feed will go on slowly but continuously so long as the series coil is not in action. When the current is turned on, the frame containing the escapement and carbon rod is lifted, striking the arc, and the top of the pendulum becomes fixed in a little nick. If the arc burns too long the shunt coil brings down the frame giving immediate relief, and

Fig. 26.



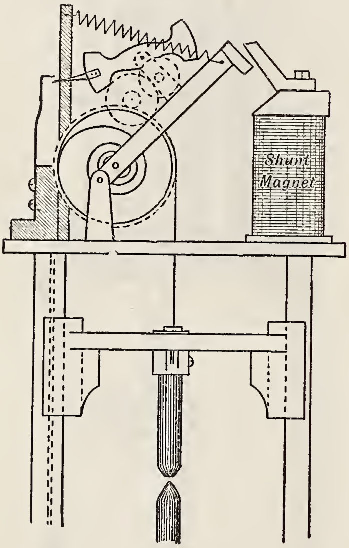
* See Alexander Siemens in "Journal Soc. Telegr. Engineers," 1880, p. 97.

when the frame has moved a little distance the pendulum is released, which in slowly allowing the escapement to operate gives permanent relief by feeding the carbon forward.

Now we come to the "flat-topped" lamp. It was a great thing to get rid of these very long carbon rods with their racks, as they took up so much vertical space. In this lamp the carbons were simply clamped to a cross-piece, top and bottom. The top cross-piece was gradually screwed down by an arrangement with a gear vibrating, almost like an electric bell mechanism, which took up a wheel tooth by tooth, and so drove the screw-feed down. This was the precursor of a much more important lamp that the firm of Siemens has been putting out for the last half dozen years.

In the "band lamp" (Fig. 27) we have the

FIG. 27.



same features, that the carbon is clamped into a heavy holder; there is no long carbon rod, the carbon is suspended on a flexible band, or cord of woven copper, that goes over a drum inside which there is a spring. The weight must be so heavy that it will uncoil that spring, and when you lift it up to put in a new carbon the spring coils itself up again. This mechanism has two toothed wheels to multiply motion, and then an escapement (with a little piece sticking out at the end of it), and the whole is carried on a frame, which can be tilted. This, again, brings us back to the tilting wheelwork which Mr. Brockie had in 1882. In the present case the only magnet is a shunt-wound electromagnet working against a spring. Supposing there is no current supplied to the lamp, that magnet does not pull; the spring pulls back the frame, and the clockwork is locked. When the lamp is put on a circuit, there is no way through it except through the shunt, the magnet will therefore pull the armature forward, which motion will lower the upper carbon a little towards the lower carbon, and make them touch; or if they do not touch, it releases the escapement, and that will work, letting the upper carbon descend until they touch. The moment the main circuit is thus completed, there will be less current going round the shunt, the spring will therefore rise, and the clockwork will be locked until such time as it is necessary for feeding to occur.

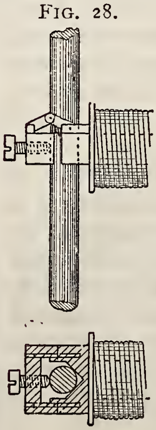
A Belgian lamp, described in 1889, illustrates this feature of the rack and wheel work turning on a pivot, which is so often found in Continental lamps.

Getting rid of the main circuit coil, and putting in only a shunt coil, though it was not well-known, is a feature which has existed a long time. There was the Lontin lamp, of 1877, a variety of the Serrin. This is the first case of a lamp working only by a shunt coil. The Serrin had a series coil to pull down a jointed parallelogram to prevent the feed occurring. In the case of the Lontin lamp the jointed parallelogram was raised by the operation of the shunt coil, and the feeding mechanism released, which otherwise was locked when the frame descended by its own weight. That is the first example of a pure shunt lamp.

IMPROVEMENTS IN CLUTCH LAMPS.

There are a few other types which have developed since 1889, amongst them the clutch lamps. The next few diagrams relate to clutches that have been developed since that time. The first (Fig. 28) is that of the Helios

FIG. 28.

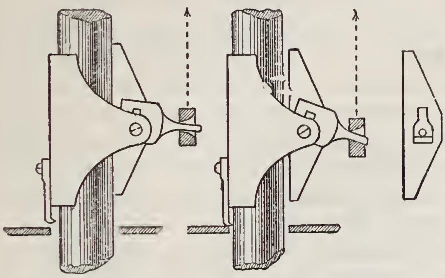


Company. Here the actual carbon comes down in front of the pole of an electro-magnet, which has a deep groove in it against which the carbon slides. A small iron armature with an adjusting screw is made to grip against that carbon rod with a sort of knee-joint above, and holds the carbon rod as long as that electromagnet does its duty, but as soon as the electro-magnet ceases to pull, as can be arranged by differential winding, the clutch release

the carbon rod, lets it slide a little bit, and then catches it again. This requires an independent arrangement for striking, but it is interesting as a form of clutch.

Then we come to the improvement in 1893 of the Brush lamp by Mr. Adams, one of the engineers of the Brush Company in Cleveland. In the old Brush the clutch was a simple ring or washer, which gripped the carbon rod, and raised it. That was replaced by Mr. Adams by a nipping clutch (Fig. 29), with a separate

FIG. 29.



toggle joint arrangement, which, in one position, pulls the clutch piece away from the carbon rod, and allows it to slip, and in the other position nips it against the rod and holds it up. The question whether the brake-piece is to be allowed to advance towards the rod and hold it, or to retreat from it, depends upon the position of the arm which comes down from the solenoid above, and depends on the larger portion of the clutch being allowed to come down into contact with the floor of the mechanism of the lamp. I have here for exhibition two lamps of the Brush Company's manufacture. One is an example of the Brush-Adams lamp, the other a Brush alternating current lamp, with laminated iron cores for the solenoids, and having the old kind of clutch.

HELIOS ARC LAMP.

Another lamp here, which has tilting clockwork, is kindly sent me by the Helios Company. We have here the feature of the two coils, series and shunt, and a kind of see-saw. The operation of that see-saw is, however, to tilt a train of wheels, and the question whether those wheels shall be allowed to turn round or not depends on the amount the clockwork is tilted over, so that hat combines the Continental feature now so common of the see-saw. This also is an alternate-current lamp; but it has the novel feature of an enamelled iron reflector set just above the end of the upper carbon, and surrounding it, so as to throw downwards (as shown in Fig. 12, p. 963) the light that otherwise would be projected obliquely upwards. A quite small mirror, fastened on a bridge between the rods that form the frame of the lamp, suffices for this purpose.

THE PLANET COMPANY'S ARC LAMPS.

Another type of lamp has been developed by the Planet Electrical Engineering Company of London. A motor is made to turn one way or the other, according as the voltage of the lamp exceeds or falls short of the prescribed amount, and the motor drives a feeding-screw. I have been usiug a Planet lamp inside this box to illustrate the Trotter phenomenon. It is one of the neat little lamps which the Planet Company is now making specially for projector work, with a motor very neatly packed away at the bottom.

SOME RECENT LAMPS.

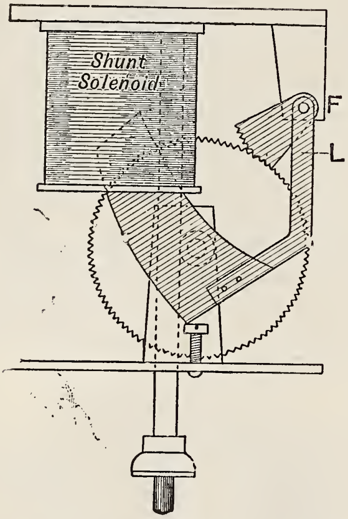
Of other feeding lamps with tilting mechanism there are several in existence. I examined a very nice one indeed some few months ago, the invention of M. Caneval, of Rouen, a shunt lamp with an escapement designed to work independently of the tilting of the mechanism.

There are here two lamps of very simple construction, the invention of Mr. Akester, of London. Both are clutch lamps, and the clutch in this case works on the holder of the lower carbon rod, instead of the upper, and the clutch itself is peculiar. It consists of a little box with some small shot in it. When the small shot is compressed between the top and bottom it grips the rod, and will not let it go. When the pressure is released the shot will roll round, and the rod will go through entirely. There is no end to these mechanical devices for clamping and unclamping automatically by the operation of that which governs the lamp, viz., the electric magnetic mechanism.

Two or three other forms containing improvements in details remain to be mentioned. First, there is here a deservedly popular French lamp, the Briane. This is like the English lamps, but having only one wheel. That wheel has a kind of tooth or milling on the edge, and is governed by a small toothed sector. That sector (Fig. 30, p. 988) is fixed to a long crooked lever, having on its end a piece of iron, which can be sucked up into a shunt coil. The play of the lever is limited by a set-screw at the bottom. If the current round

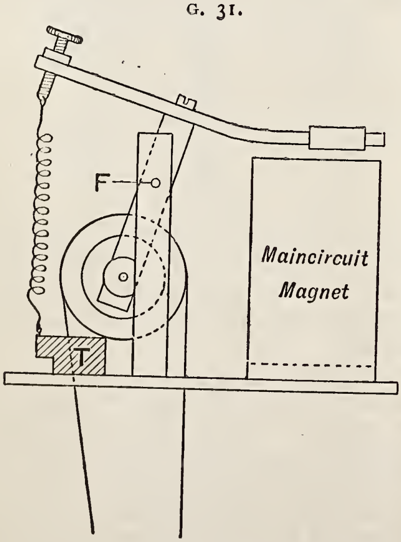
the shunt solenoid is strong enough, it will suck up this piece of iron and turn the wheel round a little. If the current is weak it will descend, and the wheel will turn the other way. Whenever the current through the shunt

FIG. 30.



solenoid becomes very strong, the rise of this piece will carry the toothed sector out of contact, and the wheel will be free to turn. But on the descent of the carbon the current in the shunt coil will at once become weaker; whereupon the lever arm comes down again,

G. 31.



and the wheel is once more caught. Naturally there will be wear and tear on these teeth; but the lamp seems to work very satisfactorily, both for continuous and alternating currents.

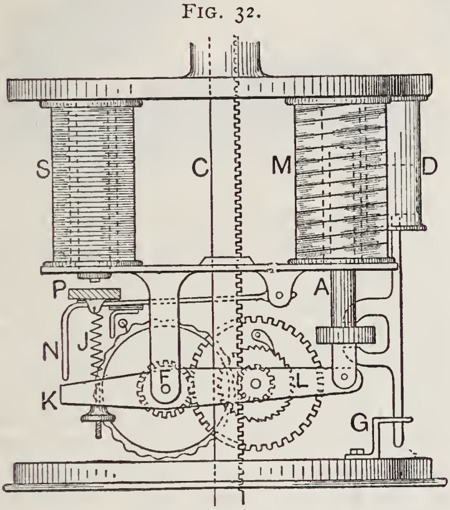
The next picture (Fig. 31) relates to a lamp not worked by a shunt solenoid. It is called the Hard lamp. We find here, again, a single wheel on a tilting frame, the position of which is, in this case, governed by a main circuit magnet pulling at an armature, and opposed by a spring. The wheel is allowed to turn, or is held against a small projecting piece at T. If the current in the main circuit is too strong, it is held fixed. If the arc burns away and the current gets weaker, the armature rises, the wheel is released, and feeding can occur.

THE "THOMSON 1893" LAMP.

In Fig. 32 is shown an American lamp. It is known as the "Thomson 1893" lamp, being the invention of Professor Elihu Thomson, who has designed many successive forms since 1874. In this case, a form has been arrived at which has some interesting features: M is a double solenoid, which carries the main current. The yoke, A, operates the lever, L, being, however, controlled by the dashpot, D. The lever, L, forms one side of a frame, pivotted at F, containing the wheelwork seen in the figure. The carbon-rod, C, gears with the first member of a train of wheels. The last member of the train will be seen to be a wheel with a wavy outline (the waves are much smaller and much more numerous than shown in the figure). The wavy rim is made of silver, and against it there falls, when the lamp is working, an insulated detent, also made of silver. This detent is mounted on a lever, to which is also attached an iron strip, P, which forms the armature of the shunt-coil, S. The shunt-coil is somewhat sluggish in action, as it has its cores surrounded by a copper tube. The fine wire wound over this has a resistance of more than 400 ohms. The connection of the shunt is made through the silver rim and detent, so that, when the detent is not in contact, the shunt circuit is broken. The action of the lamp is as follows:—When no current is passing, the lever, L, is down, and K being up, supports N, so that the wheelwork is free, and the carbons in contact. The current being turned on, lifts L, and with it the carbon-rod, C, striking the arc, and, at the same time, allowing the detent to fall, thus closing the shunt circuit. When the arc burns long, and S is strong enough, it raises the detent and the lamp feeds one tooth or wave of the silver rim, the current of S being momentarily broken. The sluggishness of S makes the action deliberate and allows the feeding to occur at variations of half a volt. Silver is an excellent metal for a contact such

as occurs in this lamp, being better than platinum for the purpose. There is no pumping with this mechanism. A number of improvements in carbon holders, dust catchers, globe shifters, &c,, accompany the lamp. For series work a cut-out is provided, which is merely a high resistance magnet as a shunt to the detent contact and made still more sluggish than S, so that ordinary feeding actions do not bring it into operation, but the opening of the coutact without feeding will give it time to act and close a shunt to the lamp. These lamps are also made to focus, and a modified type is employed with alternating currents.

FIG. 32.



The feature of the shunt acting as an electric bell vibrating arrangement was used some years ago in a lamp introduced by Gramme, which is but little known. The striking of the arc was accomplished by an electromagnet at the top of the lamp, and the feed occurred by the release of the last member of a train of clockwork by a lever which made a vibrating contact in the shunt coil circuit. The lamp further resembled the new Thomson lamp in having the series and shunt coils acting independently, the former only to strike and the latter only to feed.

THE WAX-WHEEL LAMP.

The next lamp which I exhibit is an entire novelty in the English market, though already in extensive use in America. In it all clutches, escapements, springs, and dashpots are eliminated, the feeding being accomplished by the heating effect in a shunt. To a rack on the upper carbon rod is geared a spindle carrying between two ebonite cheeks a ring made of a white composition of wax. Into the edge of this ring is embedded the head of a fixed pin, which therefore prevents the wax-wheel from turning. Upon the upper part of the pin is wound a coil of German-silver wire, having a resistance of about 150 ohms, which is included along with an auxiliary resistance of some 800 more ohms in a shunt circuit. The current which flows through this shunt circuit, though small, is sufficient to warm the pin and cause it to soften the wax in its neighbourhood, thus permitting the wax-wheel to turn round very slowly, in fact about one revolution in two or three hours, but very uniformly. The melted wax solidifies at once after having passed the pin, so that the surface of the wax-wheel is left even for the next revolution. The feeding is therefore continuous and very gradual. Should the arc grow long more current flows through the shunt making the pin hotter and causing the feed to work quicker. The rate of feeding is found to be approximately proportional to the square of the voltage applied to the shunt. This lamp, the invention of Mr. S. E. Nutting, can be used with either alternating or continuous currents. The arc is struck from below by an electromagnet in the main circuit, placed at the bottom. In the latest pattern of this lamp there is an automatic rheostat to vary the resistance of the shunt circuit according to the temperature of the surrounding air; and an ingenious cut-out has been added for lamps designed to run in series.

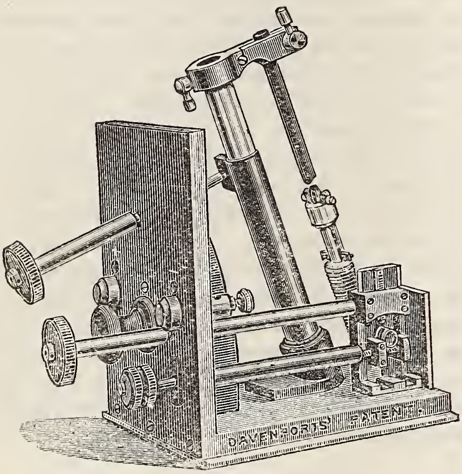
LAMPS FOR OPTICAL LANTERNS.

Since the distribution of electric current from lighting-stations became general much attention has been given to the production of small projector lamps suitable for use in the optical lantern. These are now fast replacing the limelight, and every month sees the introduction of some new forms. The principle of making the ends of the carbon abut against a solid projection, as shown in Fig. 33, is an old one, but it has been revived by Brockie, Scharnweber, and others in lamps intended for use in optical lanterns. The form of abutment usually preferred is that of three obliquely projecting claws or screws, which grip the coned surface of the carbon. For the negative carbon, a steel abutment serves excellently. For the positive carbon abutments are less satisfactory, as they are comparatively liable to be burned away by the arc.

FIG. 33.

There are on the table, thanks to the kindness of several exhibitors, some of these modern small projector lamps suitable for lantern work. First, I ought to mention the one that has done good service during my lectures. Mr. Davenport's own, of which there are two or three varieties here. That which I have been using in the lantern has an abutment pole below, with a spring to press the lower carbon against the abutting screws. There is a hand feed behind to move the upper carbon ; and there are little details of arrangement, as shown in Fig. 34, for centering and raising the luminous point.

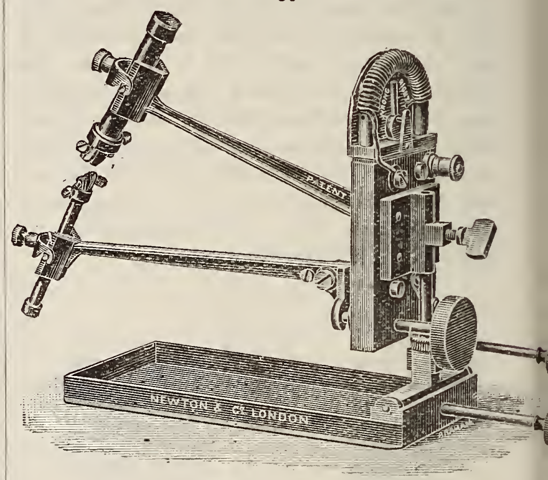
FIG. 34.



Then there are three lamps here made according to Major Holden's patent, kindly lent me by Messrs. Newton and Co., of Temple Bar. In these lamps abutment poles are used, either on the positive or negative carbons, or on both with sundry arrangements of mechanical value for changing the carbons and renewing them. Here, in the first example, are some curious contrivances to enable one to unclamp either carbon and put in a new one, as you put a new candle in a carriage lamp. In this case one has a fine hand adjustment on the lower carbon, and a coarse adjustment on the upper.

Here, again, is a somewhat similar type with hand adjustment above and below, if required. Having two sets of abutment poles, positive and negative, the carbons ought to approach at their proper rates, so that a very small amount of adjustment by hand ought to suffice. The third lamp (Fig. 35), which is of a squat pattern, is also Major Holden's. It has a device for centering, for raising and lowering the thing as a whole, and also for moving the lower carbon so as to lengthen out the arc or shorten it as desired.

FIG. 35.



Again, here is a little lamp, devised by Mr. Borland, of Leeds. It has all the elements of an arc lamp, in miniature. A coil to pull up a plunger and strike the arc, and a shunt coil to move another plunger to make the carbons approach one another. With carbons long enough to last four hours, this lamp only weighs 3 lbs. I have found it to work exceedingly well on a continuous current supply with an inverted arc, using as the lower pencil a soft cored carbon. The upper carbon, of smaller diameter and uncored, should be set slightly in front of the lower.

A very simple hand lamp with screw-feed, by Mr. A. J. Beaumont, of York, has lately claimed some notice ; but I have not had any experience with it.

Mr. Brockie has designed a very perfect small projector lamp with a vibrating clutch-feed, in which, also, abutment-stops are provided for the negative carbon ; but it belongs in reality to the class of lamps with complex mechanism, and, therefore, can scarcely be classed with the simple lamps just mentioned.

One thing has not yet been attained by the inventors of any of the automatic lamps, namely, the production of a lamp that, without any adjustment whatever, shall be capable of being connected up straight to the 100-volt mains of any lighting system, whether the supply be of the continuous or the alternate current sort. The fact is, the universal lamp, which will go anywhere with any sort of supply, has not yet been invented. Perhaps it never will come exactly in that form.

Lamps for 100-volt Circuits.

There is another direction in which progress has been taking place during the past few years, viz., in the perfection of lamps for the special purpose of running two in series on the ordinary 100-volt mains with continuous current. It is a curious fact that lamps which will work excellently when there are a lot of them in series supplied with a continuous current of fixed value, are often difficult to coax into good working when put, two in series, across 100-volt mains. Some lamps will not work at all. The inventor, however, has turned his attention to the question, and it is now often one of his most important claims that his lamp will work well under these conditions.

There is a somewhat similar problem how to make three lamps work in series when you have an alternating current supply at 100 volts. They only want 30 volts each, and therefore there ought to be room for three in series across 100-volt mains. The successful solving of that problem surely must depend on some very simple thing. Now that we have methods of testing the nicety of feed, and of adjusting the volts at which the feed will occur, clearly the time ought not to be very distant when one can say that the problem of making lamps to work satisfactorily, two or three in series on 100-volt mains, shall have been really finally solved. Mr. Brockie has remarked to me that none of the old lamps which have glycerine dash-pots to prevent the top carbon moving downwards quickly would ever perform this function, for if you would have two lamps to work satisfactorily, and not to go see-sawing one against the other, the one burning dull when the other is bright, they must be capable of dropping their carbons down into contact at the same instant, so that one shall not get down before the other, and strike its arc before the other is ready. They may move up slowly, but they must move down quickly. That is apparently one condition—possibly not the only condition—for the successful working of lamps in series.

Then I think I may conclude here, though time is all too brief for this review of progress since 1889, by saying that there are distinct lines of progress which have been traced in these six years, and that those lines of progress, although they may not yet have brought us everything we desire, nevertheless have witnessed the development of arc lighting into a condition where success has for almost every conceivable purpose been attained. It now remains only to perfect refinements for special purposes, such as those to which I have just alluded.

Miscellaneous.

CATTLE AND MEAT PRODUCTS OF RUSSIA.

Russia has lately been considering how to overcome the obstacles which hinder her export of cattle and meat to the different European markets. At present, according to the United States Consul-General at St. Petersburg, no Russian cattle are imported into Austria, England, France, or Germany, her export of cattle being confined to Turkey, Italy, Greece, and the Island of Malta. Russian sheep are not admitted into Germany or Austria, and hogs are exported only to Germany. In regard to Russian meat, it appears that only Germany places impediments in the way of its import. Although the importation of Russian meat is allowed in Germany, the Russian exporters complain that the quarantine rules are often abused, and their meat kept out. In some countries Russian meat does not suit the taste of the consumer, and this is said to be particularly the case in this country. It has lately been discovered, however, that the Russian meat possesses a certain quality of strength when prepared as beef tea which meats from other countries do not possess, and, consequently, it is much used for that purpose in hospitals and similar institutions. Russia has thus far played but an insignificant part in the export trade in animals and meat products to European markets. The largest consumer of imported meats is England. France and Germany import annually a very considerable quantity, and Belgium and Switzerland import far more animals and meats than they export. Russia exported in 1893, according to official figures, only 17,000 head of cattle, 82,000 hogs, and 163,000 sheep, and meat to the value of 175,000 roubles. The largest portion of the European demand is supplied by the United States, amounting to about three-fourths of the whole quantity imported into Europe, followed by Australia and Canada, and then South America (Argentina and Uruguay). Russia seeing what a small per-centage of the total exports she furnished, and knowing how small her home demand for such products is in comparison with the demand of the Western European countries, the Russian peasantry principally consuming vegetable food, came to the conclusion that it was necessary to devise some plan to overcome the present prejudices and obstacles that are hindering the export of her cattle and meat. The causes assigned for the unsatisfactory state of this branch of industry are the following. The prohibitory measures which are adopted by foreign Governments against Russian cattle and meat, because of the pre-

sumption that Russia has not a well organised veterinary or sanitary inspection system, and is therefore a source of murrains and epizootic diseases, against which foreign Governments enforce strict precautions; the absence of regular steamship communication with foreign ports; the lack of acquaintance with the requirements of foreign markets; careless assorting and packing of the products; the high freights on cattle and meats, with the absence of suitable cars and boats for convenient transport, and the fluctuation of the prices in Russia and abroad. A Commission has been appointed to work out a project for the improvement of the export of Russian cattle and meat. The Commission divided its work into four categories, namely:—(1) Examination of the present veterinary sanitary measures; (2) establishment of an organisation for a regular export of cattle and meat; (3) examination of the present freight rates and establishment of regular railway transport stations; and (4) examination of the tariff question.

TECHNICAL EDUCATION IN SWITZERLAND.

The great advances made by Swiss national industry in the last fifteen or sixteen years, both in the technical and artistic character of its products are certainly, says the *Deutsches Handels Archiv*, to be attributed to a great extent to the beneficial influences of State and Municipal establishments for technical education. It is very remarkable how much is done in the cantons of Geneva and Neuchatel to encourage and improve local industries, especially in finer classes of goods, for the manufacture of which a considerable amount of skill and artistic knowledge is required. In these two cantons, numbering little more than 220,000 inhabitants, there are five schools for watchmakers, and in Geneva, Neuchatel, and Chaux de Fonds there are schools for instruction in the fine arts and in artistic handicrafts. Besides the institutions there are commercial schools in Geneva and Neuchatel, and the professional schools in which instruction in various industries is given to persons of both sexes. In the watchmaking school at Geneva, a class for girls has recently been established, where certain operations peculiarly suitable for female labour are taught. Considerable assistance is also rendered to the watch industry by the astronomical observatories at Geneva and Neuchatel, both by testing chronometers, and by their co-operation in the annual trade competitions. In West Switzerland many trades which were formerly carried on almost exclusively by foreigners are now in the hands of natives. Ten or fiteen years ago the youths of Geneva were seldom taught the commoner handicraft. Those who could not devote themselves to a profession, to banking or mercantile pursuits, turned to watchmaking, jewellery, and kindred businesses. Shoemakers, tailors, bakers, butchers, carpenters, masons, cabinet makers, locksmiths, glaziers, &c., were almost all foreigners. Nowadays people are becoming more sensible of this mistake, and these trades are far less neglected by the Swiss than formerly.

Obituary.

Mr. H. D. Pochin.—Henry Davis Pochin, who died in the 72nd year of his age on October 28th, after a short illness, at Bodnant-hall, Denbighshire, was a member of the Society of Arts from 1868, and in 1872 he offered, through the late Mr. Newmarch, to provide £50 (in conjunction with Mr. Benjamin Whitworth) towards the erection of memorial tablets in London, an offer which was accepted by the Council (see *Journal*, vol. xx., pp. 491, 658). Mr. Pochin studied chemistry in early life with the view of entering business in Manchester as a manufacturing chemist, and the headquarters of his firm were established at Salford. Through his process for decomposing silicate of alumina, the article known as "aluminous cake" was introduced into commerce, and is now extensively used by paper-makers. His discovery of the method of distillation of resin with steam at a high temperature forms the basis of the modern manufacture of yellow and fancy soaps. About 30 years ago, in combination with a few business friends, he acquired some of the principal coal, iron, and steel concerns in the country, which were converted into limited liability companies. He also took up, in conjunction with Sir Edward Watkin, the affairs of the Metropolitan Railway Company, and as deputy-chairman, an office which he continued to hold until his death, took an active share in its management.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 11...Surveyors, 12, Great George-street, S.W., 8 p.m. Opening Address by the President, Mr. Daniel Watney.

Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Introductory Address by the President. 2. Mr. Arthur Montefiore, "The Progress of the Jackson-Harmsworth Arctic Expedition."

Tuesday, Nov. 12. Sanitary Institute, Margaret-street, W., 8 p.m. Mr. J. Wright-Clarke, "Details of Plumbers' Work."

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Address by the President, Sir Benjamin Baker.

Photographic, 12, Hanover-square, W., 8 p m. 1. Mr. James Cadett, "Colour Correct Photography and a New Plate." 2. Mr. W. K. Burton, "Note on the Sensitiveness of Piesated Gelatine to Light."

Anthropological, 3, Hanover-square, W., 8½ p m. Mr. Godfrey Dale, "The Customs and Habits of the Natives inhabiting the Bondee Country."

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Captain F. D. Lugard, "The Extension of British Trade in Africa."

Wednesday, Nov. 13...Japan Society, 20, Hanover-square, 8½ p.m. "Japanese Collections in the National Art Library."

Friday. Nov. 15...Sanitary Institute, 74A, Margaret-street, W., 8 p.m, Mr. W. C. Tyndale, "House Drainage,"

Journal of the Society of Arts.

No. 2,243. Vol. XLIII.

FRIDAY, NOVEMBER 15, 1895.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Forty-second Session will be held on Wednesday evening, the 20th of November, when the Opening Address will be delivered by Major-General Sir John Donnelly, K.C.B., Vice-President, and Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

November 20.—Opening Address by Major-General Sir John Donnelly, K.C.B., Chairman of the Council.

November 27.—"Locomotive Carriages for Common Roads." By H. H. Cunynghame. Sir Frederick Bramwell, Bart., D.C.L., F.R.S., will preside.

December 4.—"Mural Painting, with the Aid of Metallic Oxides and Soluble Silicates." By Mrs. Anna Lea-Merritt and Prof. W. C. Roberts-Austen, C.B., F.R.S. W. Holman Hunt will preside.

December 11.—"Water Purification by means of Iron." By F. A. Anderson.

December 18. — "Machines for Composing Letter-press Printing Surfaces." By John Southward.

Papers for meetings after Christmas:—

"Dairy Produce." By George Barham.

"The Making of a Great University for London." By Prof. Silvanus P. Thompson, D.Sc., F.R.S.

"Some Native Irish Industries." By Prof. Haddon.

"Standards of Light." By W. J. Dibden, F.C.S.

"Orthochromatic Photography." By Capt. W. de W. Abney, C.B., F.R.S.

"The Garden in Relation to the House." By F. Inigo Thomas.

"English Book Illustrations, 1860-70." By Joseph Pennell.

"Punjab Irrigation, Ancient and Modern." By Sir James Broadwood Lyall, G.C.I.E., K.C.S.I.

"The Economic Development of Kashmir." By Walter R. Lawrence, I.C.S., C.I.E.

"High Explosives and Smokeless Powders." By Hudson Maxim.

"Supply of Sea-water to London." By Frank W. Grierson.

Indian Section.

The meetings of this Section will take place on the following Thursdays, at Half-past Four o'clock:—

January 16, February 13, 27, March 12, April 23, May 14.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four o'clock, except when otherwise announced:—

December 17, January 28, February 18, March 3, 17, April 21, May 5.

December 17.—"Jamaica." By Frank Cundall, C. Washington Eves, C.M.G., will preside.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 14, February 4, 25, March 10, April 14, May 12.

Cantor Lectures.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock:—

W. Worby Beaumont, M. Inst. C. E., "Mechanical Road Carriages." Three Lectures.

Lecture I.—December 2.—Introduction—Easy transport: its attractiveness as a problem, and its national importance—Mechanical road carriages—Early inventions and achievements — Steam on common roads—Carriages and coaches—Success of English constructors—Close of early 19th century steam carriage enterprise.

Lecture II.—December 9.—Second period of 19th century invention and enterprise—Development of steam road locomotives and traction engines—Design and construction—General principles: details—Highways and road locomotives Act—Slow development under oppressive restrictions.

LECTURE III.—DECEMBER 16.—Renaissance of public interest in mechanical road carriages—Recent inventions and achievements—Steam, oil, gas, and electrical carriages, vans, and cycles — French, German, and English vehicles—Passenger carriages — Goods carriers — Roads — Legal restrictions — Pending legislation, probable great importance of mechanical carriage manufacturing industry, and advantages to traders.

DR. J. A. FLEMING, F.R.S., "Alternate Current Transformers." Four Lectures.
January 20, 27, February 3, 10.

PROF. J. M. THOMSON, F.R.S.E., "The Chemistry of Metals and Alloys employed for Building and Decorative Purposes." Three Lectures.
February 17, 24, March 2.

H. GRAHAM HARRIS, M.Inst.C.E., "Refrigeration." Three Lectures.
March 9, 16, 23.

HENRY A. MIERS, M.A., "Precious Stones." Two Lectures.
April 13, 20.

JAMES SWINBURNE, "Applied Electro-Chemistry." Four Lectures.
April 27, May 4, 11, 18.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered on Wednesday evenings, the 1st and 8th of January, at Seven p.m., by PROF. JOHN MILNE, F.R.S., on "Earthquakes, Earth Movements; and Volcanoes."

EXAMINATION PRIZES.

The Court of the Leathersellers' Company has made a grant of Five Guineas to the Society of Arts' Examination Prize Fund.

Miscellaneous.

THE PRODUCTION OF RICE IN JAPAN.

Rice is the most important of all Japanese crops; the cultivation takes up more than half of the total surface of arable land, and employs more labour, being more remunerative. The Chevalier de Warpenarst, Belgian Vice-Consul at Yokohama, states in a recent report that Japan produces two kinds of rice distinguished by a different method of cultivation, viz., the rice of the lowlands, which is watered by an ingenious system of irrigation, and the rice of the mountains. The latter requires very little water and sun, while it is impossible to have too much for the former. Mountain rice is grown on a very limited area, hardly exceeding 30,000 *tcho* (about 73,500 acres), with an average yield of 223,271 *kokou* (about 1,108,071 bushels); that is to say, the land devoted to the production of mountain rice amounts to hardly 20 per cent. of the total area planted with rice. It is only the districts in the neighbourhood of Tokio and the southern part of the island of Kiu-Shiu which produce this variety. It is by the appropriation of many acres of uncultivated mountain land that a larger production must be sought, as the lowlands at present produce all they can. Japanese rice being much in demand abroad constitutes a source of wealth for the country, but more cannot be grown unless lands hitherto waste are brought under cultivation. The Japanese farmer is commencing to realise the importance of devoting more attention to rice, and the Government is being urged to make more roads, defective means of communication forming a serious obstacle to the development of certain districts. Lowland rice is subdivided into two kinds, ordinary rice and glutinous rice, the latter forming no more than 8 per cent. of the annual crop. Ordinary rice, again, which is by far the most important kind, occupying 72 per cent. of the whole surface devoted to rice crops, includes three varieties —"early rice" forming 22 per cent., "medium rice" 44 per cent., and "late rice" 34 per cent. of the whole amount of ordinary rice cultivated. The greater part of the rice crop comes from the largest island (Hondo), which alone furnished 32,920,000 *kokou* (163,379,000 bushels) out of 41,379,000 *kokou* (205,360,000 bushels), the total amount produced in the year 1892, the three islands of Shikokou, Kin-Shin, and Yezo yielding the rest. The best irrigated lands are those of the central districts of Hondo, those of the north and west being the most productive. Torrential streams abound in Japan, and, where possible, they are laid under contribution for purposes of irrigation in the following manner. The water is first conveyed by little channels to the higher lands; these having been inundated, the water runs over a little bank on to the next terrace, and so on to a lower level still. This method of cultivation in terraces is in general use in the non-marshy parts, and if the different elevations are not always apparent, they none the less exist; exceptions to this are rare, and only to be found where it is an absolute impossibility to arrange the necessary slope. In such a case, the water has to be raised, and this is done sometimes by hydraulic wheels, turned by water or by hand, and sometimes by an arrangement with dipping buckets, which empty their contents into the channel leading to the fields. The mode of irrigation is said to be far superior to that in use in China and in Indo-China, being independent of the rains for the amount of water necessary to a good crop of rice. The rice is planted during June, in land flooded to a depth of 25 centimetres. The sowings are effected in line and in holes 15 centimetres in depth, this method having the advantage of allowing other products to be sown between the lines of green shoots, so that the planter obtains a supplementary

crop. Nearly three-quarters of the rice fields remain fallow during the winter, the latter season being too long and severe to allow of two crops everywhere, while a fourth of the most fertile lands, and of those situated in the southern parts of the empire and in the islands of Kiu-Shiu and Shikokou, furnish two crops—one of rice, the other of corn, barley, or colza. About the end of May the winter harvest is gathered in. The successive changes in the aspect of the country are very great from April to June. During its growth, water must be supplied to the rice plant in large quantities. The harvest is gathered between the end of September and the end of October, according as the crop is "early," "medium," or "late." Since 1886, Japan has produced an annual average of 40,000,000 *kokou* of rice (198,500,000 bushels). Sometimes this average is exceeded, as in 1890 and 1892, and sometimes it is not reached. Of these 40,000,000 *kokou*, 34,000,000 are for home consumption. It is the upper and middle-classes who eat rice, the poor being seldom able to obtain it, their food consisting of the leavings of the rich—stale fish and fish entrails, which are cooked all together and sold about the streets on stalls. The farmer himself eats barley, corn, millet, and the sweet potato, but rice only on *fête* days. To the 34,000,000 *kokou* for home consumption should be added, 500,000 for brewing purposes, and 3,000,000 *kokou* used in the manufacture of the drink known as saké. The export trade in rice is of no great consequence, but is capable of development. The exportation of Japanese rice commenced about 24 years ago, and since then a continued progress has been manifest, although it is said that the quality has somewhat deteriorated. The principal European markets for Japanese rice are London and Hamburg. The following nine provinces produce most rice for export, as they grow more especially the variety which is suited to European tastes:—Yamaguchi, Fukuoka, Kumamoto. Okayama, Kioto, Saga, Ehime, Meije, and Oita. They can easily supply more than half the wants of Europe by an annual exportation of 600,000 tons. The 1894 crop of Japanese rice was said to be an excellent one.

MANUFACTURE OF LEAD PENCILS.

The *Monde Economique*, quoting from a work recently issued by Ernest Faber on the manufacture of lead pencils, published on the occasion of the business of Johann Faber, of Nuremberg, being turned into a limited company, says that there are twenty-six manufactories of lead pencils in Bavaria, twenty-three of which are at Nuremburg. These employ 9,000 or 10,000 workmen, and turn out 4,400,000 lead pencils every week. In the above number of workmen are not included turners, boxmakers, &c. The factory of Johann Faber alone turns out 1,280,000 pencils per week. The protective customs duties of the United States prohibit the importation of cheap pencils, and this country itself turns out almost as many pencils as all the Bavarian factories put together. The best cedar wood of the States (*Cedrus virginiana*) will soon be exhausted, but at present, having the monopoly of internal production, a considerable amount is exported to India, Mexico, Japan, and Australia, at extraordinarily low prices. The duties in Italy (100 lire per 100 kilogrammes), in France (180 to 300 francs per 100 kilogrammes), and in Russia (35 copecks per pound) are also hindrances to importation. In France, it is stated that schools and Government offices, and even railway companies are forbidden to buy German pencils.

THE FRENCH SCHOOL SYSTEM.

Consul Monoghan, of Chemnitz, in a recent report upon technical and trade schools, says that of all the European school systems the best organised is the French. It puts the technical schools under proper supervision. The Department of Agriculture takes charge of the *Institut Agronomique*, a school for agricultural engineers; the national agricultural schools designed to develop learned and scientific studies on agriculture; schools for practical work on agricultural farm schools intended for the simplest elements of an agricultural education, and farms for horticulture; forestry schools recruited from the pupils who graduate from the *Institut Agronomique*, and the veterinary schools. Under the Ministry of Commerce and Industry are placed the central school of arts and manufactures at Paris; the schools of art and trade; commercial high schools; superior school of commerce at Paris; watch and clock-making schools; practical schools for master workmen and skilled mechanics, and schools for telegraphy. Under the Minister of War are the polytechnic schools, school of application of artillery and engineering, saltpetre and powder schools, St. Cyr (a special military school), cavalry schools, school for under-officers of infantry, schools for special training in guarding the health of soldiers, military school of medicine and pharmacy, schools of military administration, a school for the sons of soldiers and sailors in which the boys get a good military education free, and preparatory military schools. Under the Minister of Instruction and Fine Art are the Ecoles Maternelles, a kind of kindergarten school, primary schools, superior primary schools (in these, besides the ordinary instruction of primary schools, the scholars get instruction or practical ideas about agriculture, commerce, and manufactures); primary normal schools (in these the candidates must be sixteen years old at least, have diplomas from other schools, and must pass a competitive examination, and, if admitted, they must engage to serve in the public schools for six years). In these schools the courses are free: superior normal schools for graduating professors for the primary normal schools; superior normal schools for training lady teachers for the primary normal schools;

superior normal schools for training teachers for secondary education; superior schools for pharmacy; law schools, in which are taught Roman, French, and international law, and political economy; national school of paleography; special school of living Oriental languages, the purpose of this school being to train men for assistants, interpreters, &c., in the diplomatic and consular service; Practical School for High Studies (the Sorbonne is a type of this school); school of the Louvre, designed for the study of archæology and ancient civilisation; School of Fine Arts, for training artists in painting, sculpture, architecture, and engineering (this school prepares the students for the *Prix du Rome*); national schools for the fine arts at Dijon, Lyons, and Algiers; national schools of the decorative arts; a school to teach designing; technical schools for decorative art Aubusson, Limoges, Nice, and Roubaix; national schools of design for young girls; national conservatoire for music and oratory; French school at Athens to furnish professors of Greek history and archæology, &c.; School of Archæology, at Rome, to furnish professors learned in the Latin tongue, Roman history and archæology; French school at Rome to receive painters, sculptors, architects, engravers, musicians, &c., who have carried off the *Prix de Rome*. Under the Department of the Interior are national schools of deaf mutes and national schools for the blind. Under the Minister of Marine are naval schools; a school in which is taught the application of engineering to maritime subjects; colonial schools, in these are taught the colonists who come to France, also young men destined to serve France in the colonies; hydrographic schools; schools for mechanics, intended for marine engineers; school for sailors' orphans; training ship for boys intended for maritime service, and a school of medicine and pharmacy for the navy. Under the Ministry of Public Works are a school of bridges and roads (the students at this school come to it from the polytechnic schools); school of mines; school of mines for graduating practical directors of mining works, and a school for master workmen for mines. The free schools comprise schools of political sciences to prepare persons for consular and diplomatic careers for the State council, for the Treasury, and other departments; a special school for architecture; and high commercial schools. Consul Monaghan says that the French schools are similar to those of Germany, but they are better supervised and arranged. The progress of France in recent years in technical, industrial, and industrial art education is due, in no small degree, to the intelligent disposition of the burden of direction and supervision, and a happy emulative spirit that has marked the zeal of directors in different departments.

FOREST PLANTS OF THE ARGENTINE.

While the Argentine pampas, as far as the Andes, form one vast pasture of succulent grasses on which millions of horses, horned cattle, and sheep, obtain their subsistence, there is nothing in the way of forage, according to the United States Consul at Buenos Ayres, that the natives think of sufficient value to be cultivated. The native perennial pasturage of the pampas consist of two distinct classes of grass, which serve their purpose very well in the absence of anything better. One of these species of Argentine grass has received the name of *pasto duro* (hard grass), and the other, that of *pasto blando* (soft grass). The first kind up to the period of its flowering furnishes excellent nourishment for animals, but on account of its length is better for horses and cattle than for sheep. It dies after flowering, and then the leaves and stalks lose the greater part of their nutritive qualities. Cattle, however, can still subsist on it in this state for several months, and on an emergency, except in very severe weather, it will carry them through the winter. The soft grass is composed principally of *graminæ*, more or less tender and savoury, which the natives of the country know under the name of *gramillas*, but it also includes some herbaceous and juicy plants of which are worthy of mention two species of *trebol*, the ordinary and sweet-scented clover, and a species of *erodium* called *alfilerilla*, and the spotted thistle, whose tender leaves are much sought after by both cattle and sheep. Until the formation of the seed these animal plants form an excellent substitute for the grasses, but the nourishment is not of the highest quality. This spotted thistle has a bright green leaf, and grows to the height of eight or ten feet, in such dense thickets as to be impenetrable, except in the track of the cattle. With all these grasses and herbs for the subsistence and pasturage of the herds and flocks of the Argentine Republic, there is no intrinsic commercial value, as fodder or forage, set upon any of them. The only forage plant that is cultivated in the country for its crops is what is known as "alfalfa," and for productiveness there is no forage to be compared with it. In all parts of the Argentine Republic it is now thoroughly domesticated, and is the great source of the hay supply for the country. It is most admirably suited to the climate, and the fields produce from five to eight cuttings during the season. The number of acres already under this grass now reaches many millions; and such is the certainty of its croppings, and so great is the demand, both at home and abroad, for baled alfalfa, that the extent of land under this forage will soon exceed that of all other agricultural products put together. There are no statistics to show the amount of alfalfa produced in the Argentine Republic, but, in addition to the home consumption —which is very large—the amounts exported during the last three years were, in 1891, 30,004 tons; in 1892, 39,209 tons; and, in 1893, 53,523 tons. Of these shipments about two-thirds were sent to Rio Janeiro and the rest went to Europe. The Argentine *estancieros*, whose annual losses in cattle and sheep, from want of forage, have hitherto sometimes more

than eaten up the profits of the product, are beginning to see the importance of making provision for droughts and bad winter; and they are gradually, as occasion offers, putting down larger and larger breadths of their lands in alfalfa paddocks.

General Notes.

MECHANICAL CARRIAGES.—The Chicago *Times-Herald*, of November 2nd, states that the competition for mechanical carriages, which had been arranged by that paper to take place on the 1st November, was postponed until the 28th inst., at the request of a number of the competitors who had entered for the competition, but were not prepared. The *Times-Herald*, however, offered a prize of $500 (£100) to be divided amongst those competitors who went over the course arranged for the race. This course extends over the line of boulevards which surround Chicago to a place named Waukegan on the lake shore, 30 miles to the north of the city. Several vehicles started, but only one completed the course—the carriage entered by A. Mueller, of Decatur, Ill. The vehicle carries four, and is driven by a gasoline motor. The total distance covered was 92 miles, and the time taken 8 hours 44 minutes.

THE FOREIGN POPULATION OF PARIS.—It is stated on the authority of *Le Siècle*, that there is no chief city in Europe which contains such a large proportion of foreigners as Paris. In London there are 95,000 foreigners; in St. Petersburg there are 23,000, or 24 to every 1,000 inhabitants; in Vienna 35,000, or 22 per 1,000; in Berlin 18,000, or 11 per 1,000. These proportions are small in comparison with Paris, where there are 181,000 foreigners, or 75 per 1,000, to which number must be added 47,000 naturalised French subjects. In Paris there are 26,863 Germans, and in Berlin there are only 397 French people. The nationalities chiefly represented in Paris—after the German—are Belgians (45,000), Swiss (26,000), and Italian 21,000; English (13,000), and Russian 9,000. The number of aliens is rapidly increasing in Paris. In 1883 the number was estimated at 47,000; in 1851 this number had increased to 53,000; in 1876 it amounted to 119,000, and in 1891 to 181,000. Of these foreigners 8,000 only are persons of independent means; 20,000 are in business on their own account, or heads of commercial houses; 16,000 are employees; 57,500 workpeople; 17,000 domestics, and 62,000 are composed of women or children engaged in no business or profession. As a general rule foreign competition is less keen in the occupations engaged in by women than in those by men, always excepting the occupations of domestic servants and governesses.

JAPANESE COLLECTIONS.—A paper was read before the Japan Society on Wednesday, the 13th inst., by Mr. E. F. Strange, on the Japanese collections in the National Art Library. A collection of 12,000 prints have been catalogued, and are now easily accessible.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 18...British Architects, 9, Conduit-street, W., 8 p.m. Dr. Alexander S. Murray, "The Sculptured Columns of the Temple of Diana at Ephesus."

TUESDAY, Nov. 19...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. H. Greathead, "The City and South London Railway: Subaqueous Tunnelling, by Shield and Compressed Air."

Statistical (at the Royal United Service Institution, Whitehall, S.W.), 5 p.m. Mr. Lesley C. Probyn, "Gold and Silver, and the Money of the World."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Swale Vincent, "Contributions to the Comparative Anatomy and Histology of the Supra-renal Capsules."—(No. 1.) "The Supra-renal Bodies in Fishes, and their Relation to the so-called Head Kidney," 2. Mr. Gerard W. Butler, "The complete or partial Suppression of the Right Lung in the *Amphisbœnidæ*, and of the Left Lung in Snakes and Snake-like Lizards and Amphibians." 3. Mr. W. Saville Kent, "Observations on the Frilled Lizard (*Chlamydosaurus kingi*) of Western Australia." 4. Dr. A. G. Butler, "A small Collection of Butterflies made by Consul Alfred Sharpe at Zomba, British Central Africa."

WEDNESDAY, Nov. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Opening Meeting of the Session. Address by Sir John Donnelly, Chairman of Council.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. John Eliot, "The Origin of the Cold Weather Storms of the year 1893 in India, and the Character of the Air Movement on the Indian Seas and the Equatorial Belt, more especially during the South-West Monsoon Period." 2. Mr. Charles Davison, "The Diurnal Variation of Wind Velocity at Tokio, Japan." 3. Mr. W. H. Dines will show his Experiment illustrating the Formation of the Tornado Cloud.

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. M. J. Michael, "Numerical Aperture reconsidered." 2. Mr. F. Chapman, "Foraminifera of the Gault of Folkestone."

Photographic Club, Anderton's Hotel, Fleet-street, E.C., 8 p.m. Mr. Andrew Pringle, "Exhibition of Limelight Jets, and Tests of some."

THURSDAY, Nov. 21...Linnean, Burlington-house, W., 8 p.m. 1. Dr. Morris, "Development of a Single Seed in the Fruit of the Cocoanut Palm (*Cocos nucifera*)." 2. Mr. A. J. Ewart, "Assimilation in Plants under Abnormal Conditions." 3. Mr. A. C. Seward, "A New Species of *Pinites* from Wealden (England)."

Chemical, Burlington-house, W., 8 p.m. 1. Prof. Clowes—(i) "The Evolution of Carbon Monoxide by Alkaline Pyrogallol Solutions during Absorption of Oxygen;" (ii) "The Composition of the Limiting Explosive Mixtures of various Combustible Gases with Air." 2. Mr. W. H. Willcox, "Barium Butyrate and the Estimation of Butyric Acid." And other papers.

FRIDAY, Nov. 22... Physical, Burlington-house, W., 5 p.m. 1. Mr. G. Johnstone Stoney, "An Exhibition of Photographs of Spectra." 2. Mr. R. Appleyard—(i) "A Direct Reading Platinum Thermometer; (ii) "Historical Note on Resistance and its Change with Temperature."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the receipt of the following Transactions of Societies and Periodicals.

TRANSACTIONS, &c.

American Chemical Society, Journal.
American Institute of Electrical Engineers, Transactions.
American Philosophical Society, Proceedings and Transactions.
American Society of Civil Engineers, Transactions and Proceedings.
Association of Engineering Societies, Journal.
Australasian Association for the Advancement of Science, Report.
Bath and West and Southern Counties Society, Journal.
Birmingham Philosophical Society, Proceedings.
British Association for the Advancement of Science, Report.
British Guiana, Royal Agricultural and Commercial Society of, Journal.
British Horological Institute, Horological Journal.
Camera Club, Journal.
Canada, Royal Society of, Proceedings and Transactions.
Canadian Institute, Transactions.
Canadian Society of Civil Engineers, Transactions.
Chartered Institute of Patent Agents, Transactions.
Chemical Society, Journal.
Cleveland Institution of Engineers, Proceedings.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geneva, Société des Arts, Bulletin de la Classe d'Industrie et de Commerce.
Geological Society, Quarterly Journal.
Glasgow Philosophical Society, Proceedings.
Imperial Institute, Year Book and Journal.
Incorporated Gas Institute, Transactions.
India, Geological Survey of, Memoirs, Records and Palæontologia Indica.
Indian Meteorological Department, Report.
Institute of Bankers, Journal.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Electrical Engineers, Journal.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Junior Engineers, Record of Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Mining and Metallurgy, Transactions.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Jamaica, Institute of, Journal.
Japan, College of Science, Imperial University, Journal.
Japan Society, Transactions and Proceedings.
Kew Gardens Bulletin.
Linnæan Society, Journal.
Liverpool Polytechnic Society, Journal.
London Association of Foremen Engineers and Draughtsmen, Publications.
Lyon, Société d'Agriculture, Sciences et Industrie, Annales.
Manchester Literary and Philosophical Society, Memoirs and Proceedings.
Massachusetts Institute of Technology. Technology Quarterly and Proceedings of the Society of Arts.
Munich, Polytechnischer - Verein, Bayerisches Industrie-und-Gewerbeblatt.
National Association for the Promotion of Technical and Secondary Education. Record.
National Indian Association, "The Indian Magazine and Review."
Nederlandsche Maatschappij ter Bevordering van Nijverheid, Wekelijkoche Courant de Nijverheid.
New South Wales, Royal Society, Journal and Proceedings.
North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Paris, Conservatiore National des Arts et Metiers, Annales.
——, Société d'Encouragement pour l'Industrie Nationale, Bulletin.
——, Société de Geographie Commerciale, Bulletin.
——, Société Internationale des Electriciens, Bulletin.
——, Société Nationale d'Acclimatation de France, Revue.
Patent-office, Illustrated Official Journal.
Pennsylvania (Western), Engineers' Society of, Proceedings.
Pharmaceutical Society, "The Pharmaceutical Journal."
Philadelphia, Academy of Natural Sciences, Proceedings.
————, Engineers' Club of, Proceedings.
Physical Society of London, Proceedings.
Quekett Microscopical Club, Journal.
Royal Agricultural Society, Journal.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Annual Report.
Royal Geographical Society, "The Geographical Journal."

Royal Institute of British Architects, Journal.
Royal Institution of Great Britain, Proceedings.
Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal.
Royal National Life Boat Institution, "The Life Boat."
Royal Photographic Society of Great Britain, Journal.
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings.
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
Sanitary Institute, Journal.
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
Society of Dyers and Colourists, Journal.
Society of Engineers, Transactions.
Society of Public Analysts, "The Analyst."
South Wales Institute of Engineers, Proceedings.
Tasmania, Royal Society of, Papers and Proceedings.
Victoria Institute, Journal of the Transactions.

PERIODICALS.

Twice a Week.

Chemiker-Zeitung.

Weekly.

Amateur Photographer.
American Architect and Building News.
American Gas Light Journal.
American Manufacturer and Iron World.
Architect.
Architecture and Building (New York).
Athenæum.
Bradstreet's.
British Architect.
British Journal of Photography.
Builder.
Building News.
Capitalist.
Chemical News.
Chemist and Druggist.
Civil Service Competitor.
Colliery Guardian.
Colonies and India.
Commerce.
Cosmos; Revue des Sciences.
Eclairage Electrique.
Electrical Engineer.
Electrical Review.
Electrician.
Electricien.
Electricity.
Engineer.
Engineering.
Engineering Record (New York).
English Mechanic.
European Mail.
Gardeners' Chronicle.
Gardening World.
Herapath's Railway Journal.
Indian and Eastern Engineer.
Industries and Iron.
Invention.
Iron and Coal Trades Review.
Jewelers' Weekly (New York).
Journal of Gas Lighting.
Journal d'Hygiène.
Land and Water.
Medical Press and Circular.
Miller.
Millers' Gazette.
Mining Journal.
Moniteur Industriel.
Musical Standard.
Nature.
Photographic News.
Photography.
Practical Engineer.
Produce Markets' Review.
Publishers' Circular.
Queen.
Revue Industrielle.
Sanitary Record.
School Board Chronicle.
Schoolmaster.
Scientific American.
Statist.
Surveyor.
Technical World.
Transport.
Textile Mercury.
Warehousemen and Drapers' Trade Journal.
Work.

Fortnightly.

Brewers' Guardian.
Corps Gras Industriels.
County Brewers' Gazette.
Finance Chronicle.
Irish Builder.
Jeweller and Metalworker.
Moniteur des Produits Chimiques.
Perak Government Gazette.

Monthly.

Artist.
Bookseller.
Brewers' Journal.
Building Societies' Gazette.
Cabinet Maker and Art Furnisher.
Canadian Patent Office Record.
Caterer and Refreshment Contractors' Gazette.
Cigar and Tobacco World.
Confectioners' Union.
Dyer and Calico Printer.
Educational Times.
Electrical Plant and Electrical Industries.

Engineering Magazine (New York).
Furniture and Decoration.
Giornale del Genio Civile.
Hardware Trade Journal.
Inland Architect (Chicago).
Irish Textile Journal.
Ironmongery.
Leather Trades' Circular.
Machinery Market.
Marine Engineer.
Moniteur Scientifique.
Musical Times.
Nautical Magazine.
Oestereichische Monatsschrift für den Orient.
Oils, Colours, and Dry Salteries.
Painting and Decorating.
Paper Makers' Monthly Trade Journal.
Plumber and Decorator.
Propriété Industrielle.
Railway Engineer.
Saddlers, Harness Makers, and Carriage Builders' Gazette.
Sugar Cane.
Symons's Monthly Meteorological Magazine.
Textile Recorder.
Ulster Agriculturist.
Watchmaker, Jeweller, and Silversmith.

Two-Monthly.

Coach Builders', Harness Makers', and Saddlers' Art Journal.

NEWSPAPERS.

Bombay Gazette (Overland Summary).
Ceylon Observer (Overland Edition).
Daily Inter Ocean (Chicago).
Home and Colonial Mail.
Home News.
London Commercial Record.
London and China Telegraph.
Madagascar News.
Newcastle Weekly Chronicle.
Nottinghamshire Guardian.
Shipping Gazette and Lloyd's List (Weekly Summary).
Siècle (Paris).
South African Empire.
Times of Ceylon (Weekly Summary).
Times-Herald, Chicago.
Times of India (Overland Weekly Edition).
West London Observer.

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PRINTED BY WILLIAM TROUNCE, 10, GOUGH-SQUARE, FLEET-STREET, LONDON, E.C.